

POWERS OF TEN

10^{-12}	10^{-9}	10^{-6}	10^{-3}	10^{-2}	1	10^3	10^6	10^9
p	n	μ	m	c		k	M	G
PICO	NANO	MICRO	MILLI	CENTA		KILO	MEGA	GIGA

$$22,000 \text{ nF} = 22 \text{ } \mu\text{F}$$

$$3.525 \text{ MHz} = 3525 \text{ kHz}$$

$$3,725 \text{ kHz} = 3,725,000 \text{ Hz}$$

$$3000 \text{ mA} = 3 \text{ Amps}$$

$$3500 \text{ mV} = 3.5 \text{ Volts}$$

$$1000 \text{ Hz} = 1 \text{ kHz}$$

$$1.265 \text{ GHz} = 1265 \text{ MHz}$$

$$1,000,000 \text{ pF} = 1 \text{ Microfarad}$$

$$400 \text{ Centimeter} = 4 \text{ Meters}$$

$$500,000 \text{ Microfarads} = .5 \text{ Farads}$$

G5C17

What is the value in nanofarads (nF) of a 22,000 pF capacitor?

- A. 0.22 nF
- B. 2.2 nF
- C. 22 nF
- D. 220 nF

G5C18

What is the value in microfarads of a 4700 nanofarad (nF) capacitor?

- A. 47 μF
- B. 0.47 μF
- C. 47,000 μF
- D. 4.7 μF

BASIC UNITS

Voltage or electromotive force

Pressure or force

Volt

Symbol = E

Current

Electron flow

Amp

Symbol = I

Resistance

Impedes current flow

Ohm

Symbol = R

1 volt at 1 amp = 1 ohm

Power

How fast electrical energy is used

Watt

Symbol = P

BASIC UNITS 2

Frequency

The rate that AC changes

Hertz or cycles per second

Audio

Standard human hearing

20 Hertz to 20,000 Hertz

Radio frequency

Above 20 kHz

Wavelength

Length of one cycle

Meters

Wavelength = $300 / \text{frequency}$
in MHz

DC

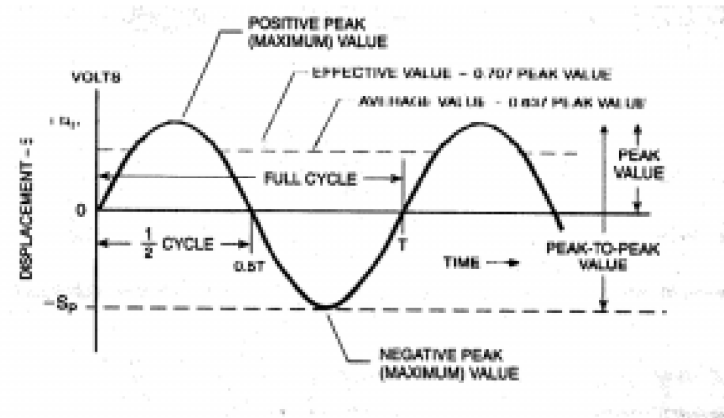
DC or direct current

Current flows in one direction only

Resistance not reactance

Automotive = 12 volts DC

AC



- **AC or alternating current**
 - Current changes direction
 - Reactance or Impedance in Ohms
 - Measured in
 - Root Mean Square (rms) 0.707 of peak
 - Same Heat as DC voltage
 - Peak to Peak 2.828 X rms
 - Peak 1.414 X rms
- **House voltage = 117 volts**
 - 60 hertz

G5B09

What is the RMS voltage of a sine wave with a value of 17 volts peak?

- A. 8.5 volts
- B. 12 volts
- C. 24 volts
- D. 34 volts

G5B07

What value of an AC signal produces the same power dissipation in a resistor as a DC voltage of the same value?

- A. The peak-to-peak value
- B. The peak value
- C. The RMS value
- D. The reciprocal of the RMS value

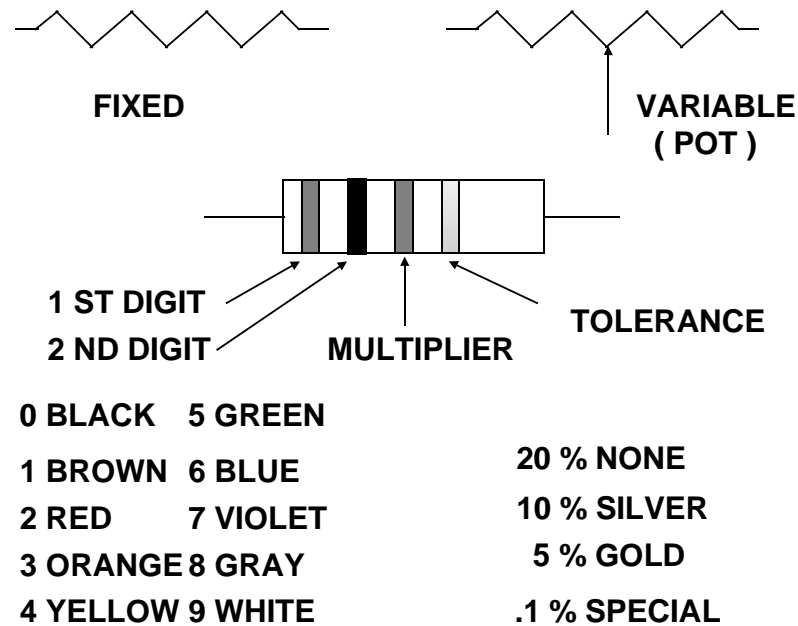
G5B08

What is the peak-to-peak voltage of a sine wave with an RMS voltage of 120.0 volts?

- A. 84.8 volts
- B. 169.7 volts
- C. 240.0 volts
- D. 339.4 volts

RESISTOR

**Resistors Dissipate Power &
Control or Limit Current**



RESISTORS

•In series add $R_T = R_1 + R_2 + R_3$

•In parallel

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

- 2 equal values in parallel
= one half the value
2 100 ohm resistors = 50 ohms
Always less than either resistor
- Temperature coefficient
 - Plus, Minus, Zero
- Wire-wound resistors are inductive

G5C03

Which of the following components should be added to an existing resistor to increase the resistance?

- A. A resistor in parallel
- B. A resistor in series
- C. A capacitor in series
- D. A capacitor in parallel

G5C05

If three equal value resistors in series produce 450 ohms, what is the value of each resistor?

- A. 1500 ohms
- B. 90 ohms
- C. 150 ohms
- D. 175 ohms

G5C04

What is the total resistance of three 100 ohm resistors in parallel?

- A. 0.30 ohms
- B. 0.33 ohms
- C. 33.3 ohms
- D. 300 ohms

G5C15

What is the total resistance of a 10 ohm, a 20 ohm, and a 50 ohm resistor connected in parallel?

- A. 5.9 ohms
- B. 0.17 ohms
- C. 10000 ohms
- D. 80 ohms

G6A06

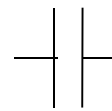
Which of the following is a reason not to use wire-wound resistors in an RF circuit?

- A. The resistor's tolerance value would not be adequate for such a circuit
- B. The resistor's inductance could make circuit performance unpredictable
- C. The resistor could overheat
- D. The resistor's internal capacitance would detune the circuit

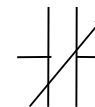
CAPACITOR

- Opposes a change in voltage
- Stores energy in an electrostatic field
- Blocks DC
- Passes AC
- Parallel connected add
- Series smaller than the smallest
- Ceramic
 - Low cost
- Electrolytic
 - Large values
 - Polarity

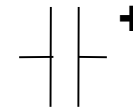
$$X_c = \frac{1}{2\pi fC} \text{ in Ohms}$$



FIXED



VARIABLE



ELECTROLYTIC

G5C13

Which of the following components should be added to a capacitor to increase the capacitance?

- A. An inductor in series
- B. A resistor in series
- C. A capacitor in parallel
- D. A capacitor in series

G5C12

What is the capacitance of a 20 microfarad capacitor connected in series with a 50 microfarad capacitor?

- A. 0.07 microfarads
- B. 14.3 microfarads
- C. 70 microfarads
- D. 1000 microfarads

G6A13

Why is the polarity of applied voltages important for polarized capacitors?

- A. Incorrect polarity can cause the capacitor to short-circuit
- B. Reverse voltages can destroy the dielectric layer of an electrolytic capacitor
- C. The capacitor could overheat and explode
- D. All of these choices are correct

G5C08

What is the equivalent capacitance of TWO 5.0 nanofarad capacitors and one 750 picofarad capacitor connected in parallel?

- A. 576.9 nanofarads
- B. 1733 picofarads
- C. 3583 picofarads
- D. 10.750 nanofarads

G5A06

How does a capacitor react to AC?

- A. As the frequency of the applied AC increases, the reactance decreases
- B. As the frequency of the applied AC increases, the reactance increases
- C. As the amplitude of the applied AC increases, the reactance increases
- D. As the amplitude of the applied AC increases, the reactance decreases

G5C09

What is the capacitance of three 100 microfarad capacitors connected in series?

- A. 0.30 microfarads
- B. 0.33 microfarads
- C. 33.3 microfarads
- D. 300 microfarads

G5A04

Which of the following causes opposition to the flow of alternating current in a capacitor?

- A. Conductance
- B. Reluctance
- C. Reactance
- D. Admittance

G6A14

Which of the following is an advantage of ceramic capacitors as compared to other types of capacitors?

- A. Tight tolerance
- B. High stability
- C. High capacitance for given volume
- D. Comparatively low cost

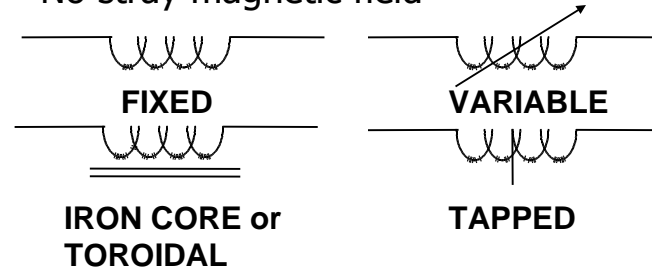
G6A04

Which of the following is an advantage of an electrolytic capacitor?

- A. Tight tolerance
- B. Much less leakage than any other type
- C. High capacitance for a given volume
- D. Inexpensive RF capacitor

INDUCTOR

- Opposes a change of current
- Stores energy in a magnetic field
- Series connected add
- Parallel Smaller than the smallest
- Have Mutual Inductance
 - 90 Degrees to minimize
- Can Self-resonate and Become a Capacitor
- **$X_L = 2\pi fL$ in Ohms**
- Ferrite Beads
 - Characteristics Change with Mix
- Toroidal
 - More bang for the buck
 - No stray magnetic field



G5C14

Which of the following components should be added to an inductor to increase the inductance?

- A. A capacitor in series
- B. A resistor in parallel
- C. An inductor in parallel
- D. An inductor in series

G5C11

What is the inductance of a 20 millihenry inductor connected in series with a 50 millihenry inductor?

- A. 0.07 millihenrys
- B. 14.3 millihenrys
- C. 70 millihenrys
- D. 1000 millihenrys

G5C10

What is the inductance of three 10 millihenry inductors connected in parallel?

- A. 0.30 henrys
- B. 3.3 henrys
- C. 3.3 millihenrys
- D. 30 millihenrys

G6A08

What is an advantage of using a ferrite core toroidal inductor?

- A. Large values of inductance may be obtained
- B. The magnetic properties of the core may be optimized for a specific range of frequencies
- C. Most of the magnetic field is contained in the core
- D. All of these choices are correct

G5A03

Which of the following causes opposition to the flow of alternating current in an inductor?

- A. Conductance
- B. Reluctance
- C. Admittance
- D. Reactance

G5A05

How does an inductor react to AC?

- A. As the frequency of the applied AC increases, the reactance decreases
- B. As the amplitude of the applied AC increases, the reactance increases
- C. As the amplitude of the applied AC increases, the reactance decreases
- D. As the frequency of the applied AC increases, the reactance increases

G6B10

How does a ferrite bead or core reduce common-mode RF current on the shield of a coaxial cable?

- A. By creating an impedance in the current's path
- B. It converts common-mode current to differential mode
- C. By creating an out-of-phase current to cancel the common-mode current
- D. Ferrites expel magnetic fields

G6B01

What determines the performance of a ferrite core at different frequencies?

- A. Its conductivity
- B. Its thickness
- C. The composition, or "mix," of materials used
- D. The ratio of outer diameter to inner diameter

G5A02**What is reactance?**

- A. Opposition to the flow of direct current caused by resistance
- B. Opposition to the flow of alternating current caused by capacitance or inductance
- C. A property of ideal resistors in AC circuits
- D. A large spark produced at switch contacts when an inductor is de-energized

G5A01**What is impedance?**

- A. The electric charge stored by a capacitor
- B. The inverse of resistance
- C. The opposition to the flow of current in an AC circuit
- D. The force of repulsion between two similar electric fields

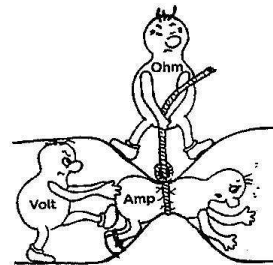
G5A09**What unit is used to measure reactance?**

- A. Farad
- B. Ohm
- C. Ampere
- D. Siemens

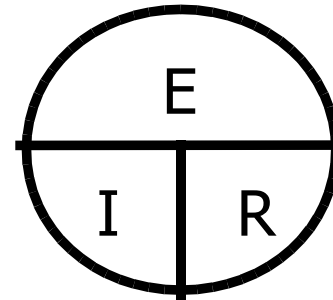
G6A11**What happens when an inductor is operated above its self-resonant frequency?**

- A. Its reactance increases
- B. Harmonics are generated
- C. It becomes capacitive
- D. Catastrophic failure is likely

OHM'S LAW



$$E = I R$$

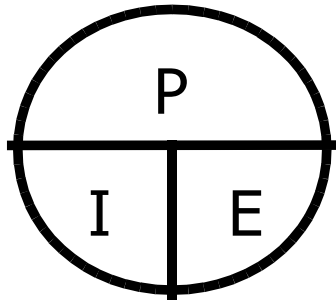


$$I = \frac{E}{R}$$

$$R = \frac{E}{I}$$

POWER LAW

$$P = EI$$



$$I = \frac{P}{E}$$

$$E = \frac{P}{I}$$

G5B04

How many watts of electrical power are used by a 12 VDC light bulb that draws 0.2 amperes?

- A. 2.4 watts
- B. 24 watts
- C. 6 watts
- D. 60 watts

Math Review

Substitution

$$P = E \times I$$

$$I = E / R$$

$$P = E \times E / R$$

Algebra Review

What ever you do to one side
of an equation you have to do
to the other

$$P = E \times E / R$$

Multiply by R

$$P \times R = E \times E$$

Square Root

$$E = \sqrt{P \times R}$$

$$P = E \text{ Squared} / R \text{ or } E = \text{Square root of } P \times R$$

G5B12

What would be the RMS voltage across a 50 ohm dummy load dissipating 1200 watts?

- A. 173 volts
- B. 245 volts
- C. 346 volts
- D. 692 volts

$$500 \text{ Vpp} = 176.8 \text{ Vrms}$$

$$P = E \text{ Squared} / R$$

G5B14

What is the output PEP from a transmitter if an oscilloscope measures 500 volts peak-to-peak across a 50 ohm resistive load connected to the transmitter output?

- A. 8.75 watts
- B. 625 watts
- C. 2500 watts
- D. 5000 watts

G5B03

How many watts of electrical power are used if 400 VDC is supplied to an 800 ohm load?

- A. 0.5 watts
- B. 200 watts
- C. 400 watts
- D. 3200 watts

$P = I^2 R$

G5B05

How many watts are dissipated when a current of 7.0 milliamperes flows through 1.25 kilohms resistance?

- A. Approximately 61 milliwatts
- B. Approximately 61 watts
- C. Approximately 11 milliwatts
- D. Approximately 11 watts

$P = E^2 / R$

G5B06

What is the output PEP from a transmitter if an oscilloscope measures 200 volts peak-to-peak across a 50 ohm dummy load connected to the transmitter output?

- A. 1.4 watts
- B. 100 watts
- C. 353.5 watts
- D. 400 watts

Peak Envelope Power

PEP is the RMS Power at max

Modulation

Sneaky trick

G5B11

What is the ratio of peak envelope power to average power for an unmodulated carrier?

- A. 0.707
- B. 1.00
- C. 1.414
- D. 2.00

G5B13

What is the output PEP of an unmodulated carrier if an average reading wattmeter connected to the transmitter output indicates 1060 watts?

- A. 530 watts
- B. 1060 watts
- C. 1500 watts
- D. 2120 watts

Kirchhoff's Law

**Current entering a point must =
the current leaving that point**

Voltage around a circuit = Zero

G5B02

How does the total current relate to the individual currents in each branch of a purely resistive parallel circuit?

- A. It equals the average of each branch current
- B. It decreases as more parallel branches are added to the circuit
- C. It equals the sum of the currents through each branch
- D. It is the sum of the reciprocal of each individual voltage drop

Transformer

Primary winding(s)

Input

Secondary winding(s)

Output

Turns ratio N_p/N_s

Voltage ratio

Impedance ratio

$\sqrt{\text{turns ratio}}$

Core Saturation (Bad)

Magnetizing Current (Losses)

Suppressor Cap

Across Secondary

Absorbs Transients

G5C01

What causes a voltage to appear across the secondary winding of a transformer when an AC voltage source is connected across its primary winding?

- A. Capacitive coupling**
- B. Displacement current coupling
- C. Mutual inductance
- D. Mutual capacitance

G5C02

What happens if you reverse the primary and secondary windings of a 4:1 voltage step down transformer?

- A. The secondary voltage becomes 4 times the primary voltage
- B. The transformer no longer functions as it is a unidirectional device
- C. Additional resistance must be added in series with the primary to prevent overload
- D. Additional resistance must be added in parallel with the secondary to prevent overload

G5C06

What is the RMS voltage across a 500-turn secondary winding in a transformer if the 2250-turn primary is connected to 120 VAC?

- A. 2370 volts
- B. 540 volts
- C. 26.7 volts
- D. 5.9 volts

G5C07

What is the turns ratio of a transformer used to match an audio amplifier having 600 ohm output impedance to a speaker having 4 ohm impedance?

- A. 12.2 to 1
- B. 24.4 to 1
- C. 150 to 1
- D. 300 to 1

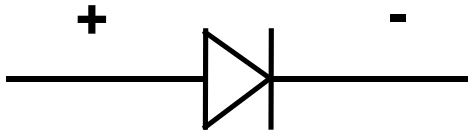
G5C16

Why is the conductor of the primary winding of many voltage step up transformers larger in diameter than the conductor of the secondary winding?

- A. To improve the coupling between the primary and secondary
- B. To accommodate the higher current of the primary
- C. To prevent parasitic oscillations due to resistive losses in the primary
- D. To insure that the volume of the primary winding is equal to the volume of the secondary winding

DIODE

- Solid state or Tube
- Allows current flow only in one direction
- Symbol is backwards
- Rectifier (another name for diode)
- PIV Peak Inverse Voltage (B4 it Smokes)
- Forward Voltage
 - Silicon about .7V (That the Answer)
 - Germanium about .3V (That the Answer)
- Multiple Diodes need Resistors
- Schottky Diode
 - Lower Capacitance



G6A03

What is the approximate junction threshold voltage of a germanium diode?

- A. 0.1 volt
- B. 0.3 volts
- C. 0.7 volts
- D. 1.0 volts

G6A05

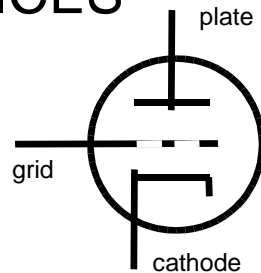
What is the approximate junction threshold voltage of a conventional silicon diode?

- A. 0.1 volt
- B. 0.3 volts
- C. 0.7 volts
- D. 1.0 volts

ACTIVE DEVICES

- Tube

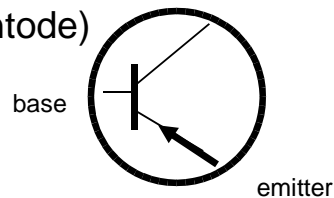
- High voltage
- Low current
- Grids
 - Control (Triode)
 - Screen (Tetrode) grid-to-plate capacitance
 - Suppressor (Pentode)



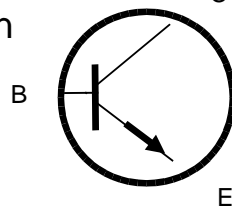
**TRIODE
TUBE**
collector

- Transistor

- Low voltage
- Saturation
- Cutoff
- May require Insulation



PNP



NPN

G6A10

Which element of a triode vacuum tube is used to regulate the flow of electrons between cathode and plate?

- A. Control grid
- B. Heater
- C. Screen Grid
- D. Trigger electrode

G6A12

What is the primary purpose of a screen grid in a vacuum tube?

- A. To reduce grid-to-plate capacitance
- B. To increase efficiency
- C. To increase the control grid resistance
- D. To decrease plate resistance

G6A07

What are the stable operating points for a bipolar transistor used as a switch in a logic circuit?

- A. Its saturation and cutoff regions
- B. Its active region (between the cutoff and saturation regions)
- C. Its peak and valley current points
- D. Its enhancement and depletion modes

More ACTIVE DEVICES

FET Field Effect Transistor

Acts like a tube

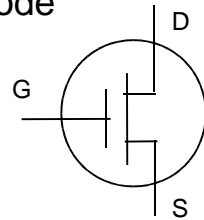
Gate = Control Grid

Source = Cathode

Drain = Plate

MOSFET

Insulated Gate



G6A09

Which of the following describes the construction of a MOSFET?

- A. The gate is formed by a back-biased junction
- B. The gate is separated from the channel with a thin insulating layer
- C. The source is separated from the drain by a thin insulating layer
- D. The source is formed by depositing metal on silicon

Impedance Matching

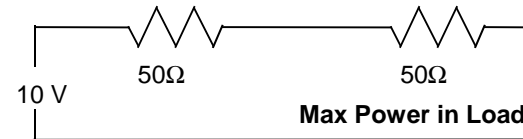
If Source = Load

Max Power Transfer



If Load = Short Then No Power in Load

If Load = Open Then No Power in Load



G5A07

What happens when the impedance of an electrical load is equal to the output impedance of a power source, assuming both impedances are resistive?

- A. The source delivers minimum power to the load
- B. The electrical load is shorted
- C. No current can flow through the circuit
- D. The source can deliver maximum power to the load

G5A08

What is one reason to use an impedance matching transformer?

- A. To minimize transmitter power output
- B. To maximize the transfer of power
- C. To reduce power supply ripple
- D. To minimize radiation resistance

G7C06

What should be the impedance of a low-pass filter as compared to the impedance of the transmission line into which it is inserted?

- A. Substantially higher
- B. About the same
- C. Substantially lower
- D. Twice the transmission line impedance

Impedance Matching 2

LC network

Pi-network

Transformer

Length of transmission line

G5A11

Which of the following describes one method of impedance matching between two AC circuits?

- A. Insert an LC network between the two circuits
- B. Reduce the power output of the first circuit
- C. Increase the power output of the first circuit
- D. Insert a circulator between the two circuits

G5A10

Which of the following devices can be used for impedance matching at radio frequencies?

- A. A transformer
- B. A Pi-network
- C. A length of transmission line
- D. All of these choices are correct

Decibel or dB

Alexander Graham Bell

Sound Pressure

1dB = The amount the kids turns
down the volume when you tell
them it's too loud

dB = 20 Log Vo/Vin

dB = 10 log Po/Pin

Log Base 10

3dB = 2X or ½ Power

20 dB = 100X or .01 Power

1 S unit = 6dB

1dB = 10dB – 9dB or 10x - 8x or

About 20%

G4D07

How much must the power output of a transmitter be raised to change the S meter reading on a distant receiver from S8 to S9?

- A. Approximately 1.5 times
- B. Approximately 2 times
- C. Approximately 4 times
- D. Approximately 8 times

G5B01

What dB change represents a two-times increase or decrease in power?

- A. Approximately 2 dB
- B. Approximately 3 dB
- C. Approximately 6 dB
- D. Approximately 12 dB

G5B10

What percentage of power loss would result from a transmission line loss of 1 dB?

- A. 10.9 percent
- B. 12.2 percent
- C. 20.5 percent
- D. 25.9 percent

G4D05

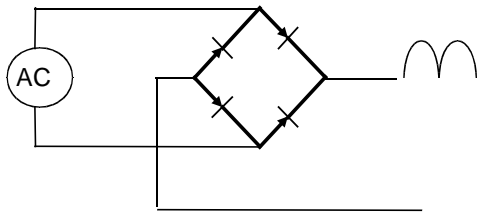
How does a signal that reads 20 dB over S9 compare to one that reads S9 on a receiver, assuming a properly calibrated S meter?

- A. It is 10 times less powerful
- B. It is 20 times less powerful
- C. It is 20 times more powerful
- D. It is 100 times more powerful

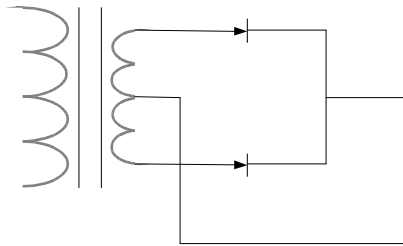
Rectifiers

Full-Wave Bridge Rectifier

Converts Sine Wave to 2 Pulses



Full-Wave Rectifier



G7A03

Which type of rectifier circuit uses two diodes and a center-tapped transformer?

- A. Full-wave
- B. Full-wave bridge
- C. Half-wave
- D. Synchronous

G7A06

What portion of the AC cycle is converted to DC by a full-wave rectifier?

- A. 90 degrees
- B. 180 degrees
- C. 270 degrees
- D. 360 degrees

G7A07

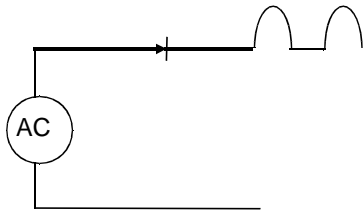
What is the output waveform of an unfiltered full-wave rectifier connected to a resistive load?

- A. A series of DC pulses at twice the frequency of the AC input
- B. A series of DC pulses at the same frequency as the AC input
- C. A sine wave at half the frequency of the AC input
- D. A steady DC voltage

Half Wave

Half-Wave Rectifier

Converts Sine Wave to 1 Pulse



G7A04

What is an advantage of a half-wave rectifier in a power supply?

- A. Only one diode is required
- B. The ripple frequency is twice that of a full-wave rectifier
- C. More current can be drawn from the half-wave rectifier
- D. The output voltage is two times the peak output voltage of the transformer

G7A05

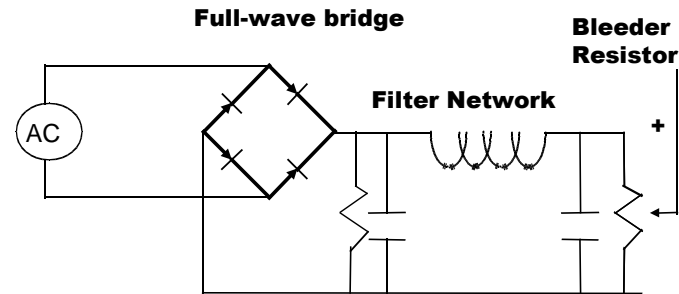
What portion of the AC cycle is converted to DC by a half-wave rectifier?

- A. 90 degrees
- B. 180 degrees
- C. 270 degrees
- D. 360 degrees

KN6FW

43

Power Supply



G7A02

Which of the following components are used in a power supply filter network?

- A. Diodes
- B. Transformers and transducers
- C. Quartz crystals
- D. Capacitors and inductors

G7A01

What useful feature does a power supply bleeder resistor provide?

- A. It acts as a fuse for excess voltage
- B. It ensures that the filter capacitors are discharged when power is removed
- C. It removes shock hazards from the induction coils
- D. It eliminates ground loop current

KN6FW

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Peak Inverse Voltage

The Voltage Across A Diode B4
it smokes

Half-wave power supply

2X Output Voltage

The Voltage on the Filter + AC

Full-wave power supply

2 Diodes in series

1X Output Voltage

Switching Power Supply

Uses High Frequency

About 100 KHz

More Efficient

Smaller

Smaller Parts

Needs Better Caps

Low Series Resistance

G7A08

Which of the following is an advantage of a
switchmode power supply as compared to
a linear power supply?

- A. Faster switching time makes higher output voltage possible
- B. Fewer circuit components are required
- C. High frequency operation allows the use of smaller components
- D. All of these choices are correct

5 Min Break

RF Amplifiers

Efficiency = RF power / DC power

Class A

Linear

Low Distortion

Can Amplify After Mod SSB

Class C

NOT Linear

Good Efficiency

Can Amplify CW – FM

Efficiency

Output / Input Power

G7B08

How is the efficiency of an RF power amplifier determined?

- A. Divide the DC input power by the DC output power
- B. Divide the RF output power by the DC input power
- C. Multiply the RF input power by the reciprocal of the RF output power
- D. Add the RF input power to the DC output power

G7B11

For which of the following modes is a Class C power stage appropriate for amplifying a modulated signal?

- A. SSB
- B. CW
- C. AM
- D. All of these choices are correct

G7B02

Which of these classes of amplifiers has the highest efficiency?

- A. Class A
- B. Class B
- C. Class AB
- D. Class C

G7B10

Which of the following describes a linear amplifier?

- A. Any RF power amplifier used in conjunction with an amateur transceiver
- B. An amplifier in which the output preserves the input waveform
- C. A Class C high efficiency amplifier
- D. An amplifier used as a frequency multiplier

Oscillator

All oscillators use:

Positive Feedback

When a Mic Squeaks

Filter to Determine Frequency

RC Phase Shift

LC Tank Circuit

Amplification

G7B07

Which of the following are basic components of a sine wave oscillator?

- A. An amplifier and a divider
- B. A frequency multiplier and a mixer
- C. A circulator and a filter operating in a feed-forward loop
- D. A filter and an amplifier operating in a feedback loop

G7B09

What determines the frequency of an LC oscillator?

- A. The number of stages in the counter
- B. The number of stages in the divider
- C. The inductance and capacitance in the tank circuit
- D. The time delay of the lag circuit

Mixer

A Mixer takes two signals and provides an Output of the Sum, Difference, and the 2 Original Signals

Used in Receivers to Tune a Frequency

Used in Transverters to get to a Higher Frequency

A Filter is Used to Select the Sum or the Difference

G8B11

What combination of a mixer's Local Oscillator (LO) and RF input frequencies is found in the output?

- A. The ratio
- B. The average
- C. The sum and difference
- D. The arithmetic product

Neutralization

**Stops Self-oscillations
Negative Feedback**

G7B01

What is the reason for neutralizing the final amplifier stage of a transmitter?

- A. To limit the modulation index
- B. To eliminate self-oscillations
- C. To cut off the final amplifier during standby periods
- D. To keep the carrier on frequency

Battery Technology

Rechargeable

- **Lead acid**
 - Car battery / Sealed Cell
 - 2 Volts per cell
 - 6 Cells 12 Volt
 - Do not Discharge below 10.5 volt
- **NiCd / NiMH**
 - Battery Packs
 - 1.2 Volts per cell
 - Memory
 - Self Discharge 10% per Month
 - Flat Discharge
 - Low internal resistance
 - More current available
- **Lithium**
 - Battery Packs
 - 3.6 Volts per cell
 - High Power / Price
 - Slope Discharge

G6A01

What is the minimum allowable discharge voltage for maximum life of a standard 12 volt lead acid battery?

- A. 6 volts
- B. 8.5 volts
- C. 10.5 volts
- D. 12 volts

G6A02

What is an advantage of the low internal resistance of nickel-cadmium batteries?

- A. Long life
- B. High discharge current
- C. High voltage
- D. Rapid recharge

Solar Panels

Sun required

Photovoltaic conversion

About 20% Efficient

About .5 Volts per Cell

Diode required to not discharge
battery into dark panels

G4E08

What is the name of the process by which sunlight is changed directly into electricity?

- A. Photovoltaic conversion
- B. Photon emission
- C. Photosynthesis
- D. Photon decomposition

G4E09

What is the approximate open-circuit voltage from a fully illuminated silicon photovoltaic cell?

- A. 0.02 VDC
- B. 0.5 VDC
- C. 0.2 VDC
- D. 1.38 VDC

G4E10

What is the reason that a series diode is connected between a solar panel and a storage battery that is being charged by the panel?

- A. The diode serves to regulate the charging voltage to prevent overcharge
- B. The diode prevents self-discharge of the battery though the panel during times of low or no illumination
- C. The diode limits the current flowing from the panel to a safe value
- D. The diode greatly increases the efficiency during times of high illumination

Wind Power

Good source of high power

Noise

The wind is unpredictable

Need battery back-up

G4E11

Which of the following is a **disadvantage** of using wind as the primary source of power for an emergency station?

- A. The conversion efficiency from mechanical energy to electrical energy is less than 2 percent
- B. The voltage and current ratings of such systems are not compatible with amateur equipment
- C. A large energy storage system is needed to supply power when the wind is not blowing
- D. All of these choices are correct

Powering Mobiles

- 100W Radio = About 20 Amps
 - $.02\Omega$ At 20 Amps = .4 Volts
 - $13.8 - .4 = 13.4$ Volts
 - Now Your Radio is at 13.4 Volts
 - Use Big Wire
 - Connect to the Battery
 - (Not on newer cars)
 - Positive Fuse it
 - Ground Fuse it (not recommended)
 - Cigarette Lighter is NOT IT!
-

G4E03

Which of the following direct, fused power connections would be the best for a 100 watt HF mobile installation?

- A. To the battery using heavy gauge wire
- B. To the alternator or generator using heavy gauge wire
- C. To the battery using resistor wire
- D. To the alternator or generator using resistor wire

G4E04

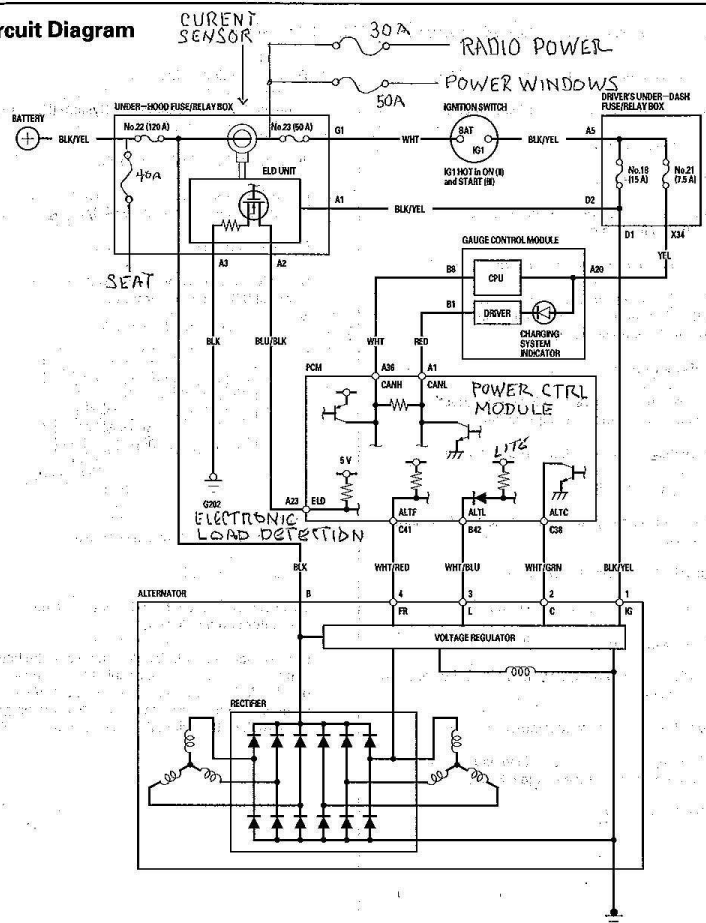
Why is it best NOT to draw the DC power for a 100 watt HF transceiver from a vehicle's auxiliary power socket?

- A. The socket is not wired with an RF-shielded power cable
- B. The socket's wiring may be inadequate for the current drawn by the transceiver
- C. The DC polarity of the socket is reversed from the polarity of modern HF transceivers
- D. Drawing more than 50 watts from this socket could cause the engine to overheat

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Circuit Diagram



KN6FW

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Test Equipment

- **S Meter on your radio**
 - Relative signal strength
 - Each model radio is different
 - 1 S unit about 6 dB or 4 times
 - 20 dB = 100 times

Multimeter

- Digital are more accurate
- Analog for tuning circuits
- Measures
 - Volts AC and DC
 - Voltmeter
 - Ohms
 - Ohm meter
 - Current Mostly DC Some AC
 - Amp meter
 - Some Measure Capacitance +
- High input impedance
 - Less load on the circuit

G4B06

What is an advantage of a digital voltmeter as compared to an analog voltmeter?

- A. Better for measuring computer circuits
- B. Better for RF measurements
- C. Better precision for most uses
- D. Faster response

G4B14

What is an instance in which the use of an instrument with analog readout may be preferred over an instrument with a digital readout?

- A. When testing logic circuits
- B. When high precision is desired
- C. When measuring the frequency of an oscillator
- D. When adjusting tuned circuits

G4B05

Why is high input impedance desirable for a voltmeter?

- A. It improves the frequency response
- B. It decreases battery consumption in the meter
- C. It improves the resolution of the readings
- D. It decreases the loading on circuits being measured

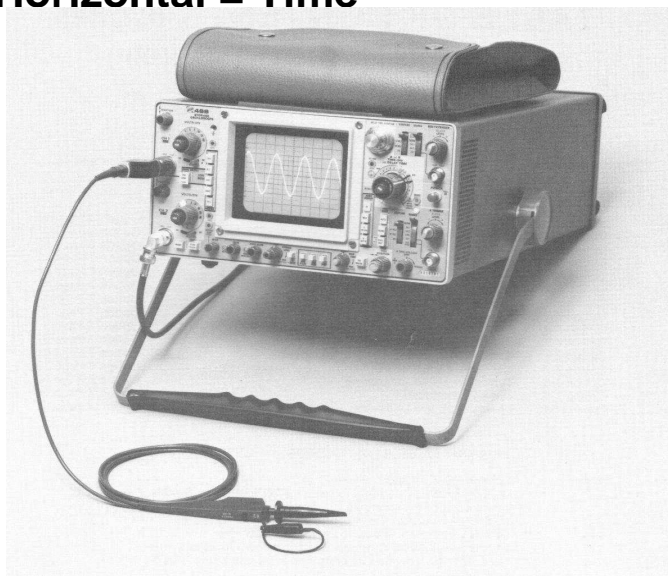
Using Meters

- **Make sure you are on the correct scale**
 - Using the wrong scale “POOF”
 - Don’t measure Voltage on resistance or current scales
- **Measure voltage in parallel**
 - Check rating for high voltage
- **Measure current in series**
- **Measure resistance out of circuit or with power off**
- **Resistance of capacitor will increase with time**

Oscilloscope

Vertical = Voltage

Horizontal = Time



G4B01

What item of test equipment contains horizontal and vertical channel amplifiers?

- A. An ohmmeter
- B. A signal generator
- C. An ammeter
- D. An oscilloscope

KN6FW

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G4B02

Which of the following is an advantage of an oscilloscope versus a digital voltmeter?

- A. An oscilloscope uses less power
- B. Complex impedances can be easily measured
- C. Input impedance is much lower
- D. Complex waveforms can be measured

G4B03

Which of the following is the best instrument to use when checking the keying waveform of a CW transmitter?

- A. An oscilloscope
- B. A field strength meter
- C. A sidetone monitor
- D. A wavemeter

G4B04

What signal source is connected to the vertical input of an oscilloscope when checking the RF envelope pattern of a transmitted signal?

- A. The local oscillator of the transmitter
- B. An external RF oscillator
- C. The transmitter balanced mixer output
- D. The attenuated RF output of the transmitter

KN6FW

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Other Test Equipment

- **Antenna Analyzer**
 - Check SWR of an antenna
 - Tune an antenna
 - Check coax impedance
- **Directional Watt meter**
 - SWR (you need to calculate)
- **Dummy Load**
 - Tune or fix your radio and not radiate
 - 50 Ohm Resistor
- **Field Strength Meter**
 - Antenna Pattern
 - Monitor RF output

G4B13

What is a use for an antenna analyzer other than measuring the SWR of an antenna system?

- A. Measuring the front to back ratio of an antenna
- B. Measuring the turns ratio of a power transformer
- C. Determining the impedance of an unknown or unmarked coaxial cable
- D. Determining the gain of a directional antenna

G4B09

Which of the following can be determined with a field strength meter?

- A. The radiation resistance of an antenna
- B. The radiation pattern of an antenna
- C. The presence and amount of phase distortion of a transmitter
- D. The presence and amount of amplitude distortion of a transmitter

G4B08

Which of the following instruments may be used to monitor relative RF output when making antenna and transmitter adjustments?

- A. A field strength meter
- B. An antenna noise bridge
- C. A multimeter
- D. A Q meter

Integrated Circuits 1

- **Analog**
 - Voltage regulator
 - Operational amplifier
 - MMIC
 - Monolithic Microwave IC
- **Display – LED**
 - Light emitting diode
 - Forward bias
 - Low power
 - LCD Liquid crystal display
 - Light polarization method
 - Back Lit or Reflected
- **Microcontroller - Microprocessor**
 - Programmable

G6B02

What is meant by the term MMIC?

- A. Multi Megabyte Integrated Circuit
- B. Monolithic Microwave Integrated Circuit
- C. Military Manufactured Integrated Circuit
- D. Mode Modulated Integrated Circuit

G6B06

What kind of device is an integrated circuit operational amplifier?

- A. Digital
- B. MMIC
- C. Programmable Logic
- D. Analog

G6B08

How is an LED biased when emitting light?

- A. Beyond cutoff
- B. At the Zener voltage
- C. Reverse Biased
- D. Forward Biased

G6B09

Which of the following is a characteristic of a liquid crystal display?

- A. It requires ambient or back lighting
- B. It offers a wide dynamic range
- C. It has a wide viewing angle
- D. All of these choices are correct

Integrated Circuits 2

Digital

- TTL
 - Older
 - + 5 volt
- CMOS
 - Low power
 - Fast

G6B03

Which of the following is an advantage of CMOS integrated circuits compared to TTL integrated circuits?

- A. Low power consumption
- B. High power handling capability
- C. Better suited for RF amplification
- D. Better suited for power supply regulation

Some CMOS also have higher power handling capability

BAD QUESTION 74AC series + or – 24 mA

74TTL series + .8mA , - 16mA

Answer is A but B is true also

Memory

- Non-volatile
 - Does not forget
 - Flash
- ROM
 - Read only memory
 - EEPROM

G6B05

What is meant when memory is characterized as non-volatile?

- A. It is resistant to radiation damage
- B. It is resistant to high temperatures
- C. The stored information is maintained even if power is removed
- D. The stored information cannot be changed once written

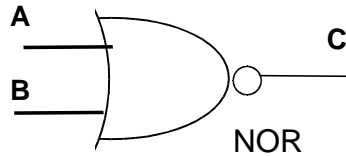
G6B04

What is meant by the term ROM?

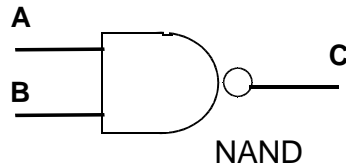
- A. Resistor Operated Memory
- B. Read Only Memory
- C. Random Operational Memory
- D. Resistant to Overload Memory

Gates

A	B	C
0	0	1
0	1	0
1	0	0
1	1	0



A	B	C
0	0	1
0	1	1
1	0	1
1	1	0



G7B03

Which of the following describes the function of a two input AND gate?

- A. Output is high when either or both inputs are low
- B. Output is high only when both inputs are high
- C. Output is low when either or both inputs are high
- D. Output is low only when both inputs are high

G7B04

Which of the following describes the function of a two input NOR gate?

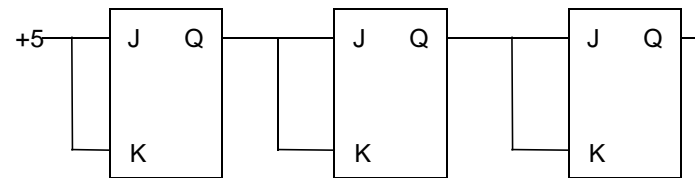
- A. Output is high when either or both inputs are low
- B. Output is high only when both inputs are high
- C. Output is low when either or both inputs are high
- D. Output is low only when both inputs are high

Binary Counter

Binary 0-1 or on – off

3 Bit counter has 8 states

$$2^3 = 8$$



G7B05

How many states does a 3-bit binary counter have?

- A. 3
- B. 6
- C. 8
- D. 16

Shift Register

Moves data 1 step at a time
Serial to parallel converter
Bucket brigade

G7B06 (A)

What is a shift register?

- A. A clocked array of circuits that passes data in steps along the array
- B. An array of operational amplifiers used for tri-state arithmetic operations
- C. A digital mixer
- D. An analog mixer

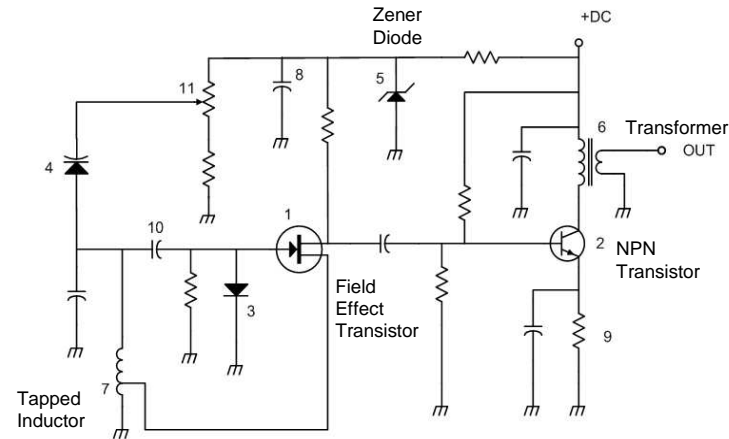


Figure G7-1

G7A13

Which symbol in Figure G7-1 represents a tapped inductor?

- A. Symbol 7
- B. Symbol 11
- C. Symbol 6
- D. Symbol 1

G7A09

Which symbol in figure G7-1 represents a field effect transistor?

- A. Symbol 2
- B. Symbol 5
- C. Symbol 1
- D. Symbol 4

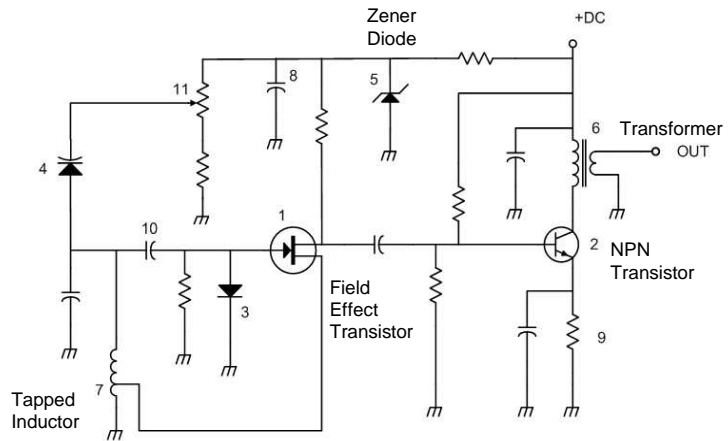


Figure G7-1

G7A10

Which symbol in figure G7-1 represents a Zener diode?

- A. Symbol 4
- B. Symbol 1
- C. Symbol 11
- D. Symbol 5

G7A11

Which symbol in figure G7-1 represents an NPN junction transistor?

- A. Symbol 1
- B. Symbol 2
- C. Symbol 7
- D. Symbol 11

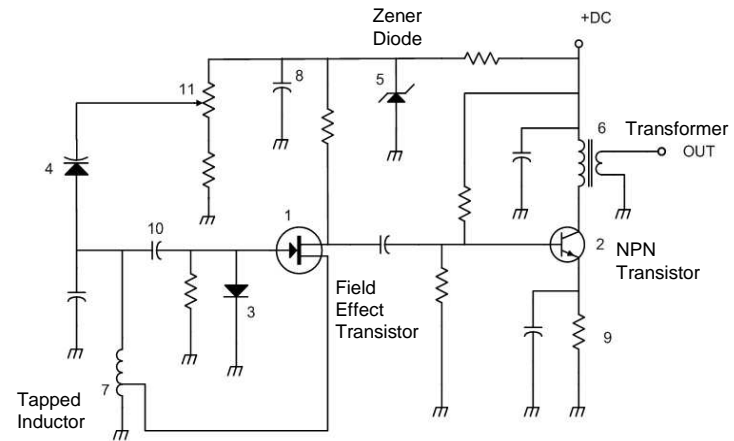


Figure G7-1

G7A12

Which symbol in Figure G7-1 represents a solid core transformer?

- A. Symbol 4
- B. Symbol 7
- C. Symbol 6
- D. Symbol 1

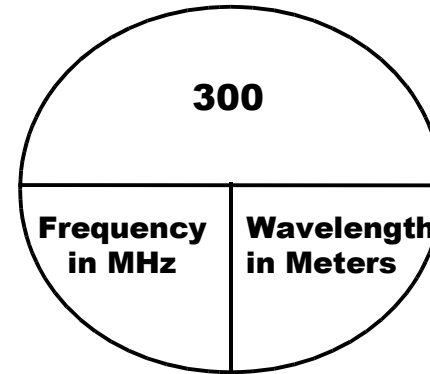
Antennas

The Perfect Antenna

Works On All Frequencies
Matches the TX Perfectly 50 Ω
Receives Very Weak Signals
Put RF Energy Where You Want It
Give You 30 dB Gain or More
Has the Perfect Ground System
Does Not Radiate Any Harmonics
Does Not Show On Your Roof
Does Not Cost Anything

And Now for Reality

ANTENNA LENGTH



Frequency x Wavelength =
300,000,000 meters per second
(Speed of Light)

Magic numbers (Not recommended)

Length of a 1/4 Wave Antenna

234 / f (in MHz) answer in ft

Length of a 1/2 Wave Antenna

468 / f (in MHz) ANSWER IN FT

G9B10

What is the approximate length for a 1/2 wave dipole antenna cut for 14.250 MHz?

- A. 8 feet
- B. 16 feet
- C. 24 feet
- D. 32 feet

Wavelength = 300,000,000 / Frequency
 300,000,000 / 14,250,000 = 21.053 Meters
 $\frac{1}{2}$ Wave = 10.526 Meters
 39.4 in per meter = 414.74 in
 12 in per foot = 34.56 ft
 If 36 in per meter = 37.894 in (This fudge factor works)
 12 in per foot = 31.57 ft

G9B11

What is the approximate length for a 1/2 wave dipole antenna cut for 3.550 MHz?

- A. 42 feet
- B. 84 feet
- C. 131 feet
- D. 263 feet

G9B12

What is the approximate length for a 1/4 wave vertical antenna cut for 28.5 MHz?

- A. 8 feet
- B. 11 feet
- C. 16 feet
- D. 21 feet

The Dipole

Simple Antenna

Height Above Ground Changes

Feed-point impedance

Decreases as the antenna approaches the ground

Increases as the feed-point is widened

.1 λ NVIS antenna

High Vertical Angle

Short Range HF Daytime

.5 λ Dipole

Low Angle Radiation

Good for 40 meter Skip

Directional

“Figure-Eight”

Lobes at 90 Degrees

Easy to install

Reference Antenna

G9B04

What is the radiation pattern of a dipole antenna in free space in the plane of the conductor?

- A. It is a figure-eight at right angles to the antenna
- B. It is a figure-eight off both ends of the antenna
- C. It is a circle (equal radiation in all directions)
- D. It has a pair of lobes on one side of the antenna and a single lobe on the other side

G9B07

How does the feed point impedance of a 1/2 wave dipole antenna change as the antenna is lowered below 1/4 wave above ground?

- A. It steadily increases
- B. It steadily decreases
- C. It peaks at about 1/8 wavelength above ground
- D. It is unaffected by the height above ground

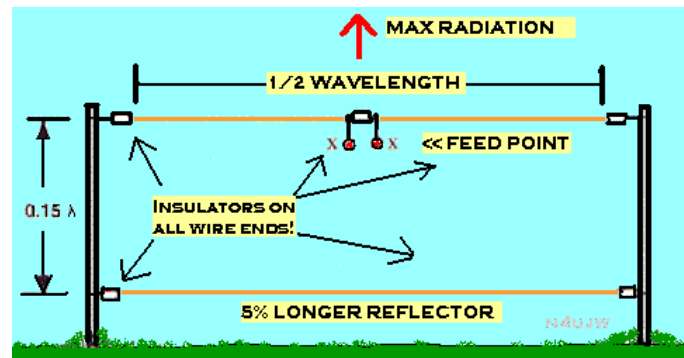
G9B08

How does the feed point impedance of a 1/2 wave dipole change as the feed point is moved from the center toward the ends?

- A. It steadily increases
- B. It steadily decreases
- C. It peaks at about 1/8 wavelength from the end
- D. It is unaffected by the location of the feed point

NVIS Antenna

Near Vertical Incidence Skywave



Used for Short Distance HF Contacts
Sure Looks Like a Yagi Pointed Up

G9D01

Which of the following antenna types will be most effective as a Near Vertical Incidence Skywave (NVIS) antenna for short-skip communications on 40 meters during the day?

- A. A horizontal dipole placed between 1/10 and 1/4 wavelength above the ground
- B. A vertical antenna placed between 1/4 and 1/2 wavelength above the ground
- C. A left-hand circularly polarized antenna
- D. A right-hand circularly polarized antenna

G3C10

What is Near Vertical Incidence Skywave (NVIS) propagation?

- A. Propagation near the MUF
- B. Short distance MF or HF propagation using high elevation angles
- C. Long path HF propagation at sunrise and sunset
- D. Double hop propagation near the LUF

15 Min Break

HF Antennas

Horizontal

Dipole

Lower Ground Reflection Losses
Below $\frac{1}{2}$ wavelength omnidirectional

Vertical

Mounts in a Small Space

Requires a Ground
Radials on the Ground
Or Buried a few inches

Multiband

Works very well on harmonics
Traps in elements (tuned circuits)
One Feed Line

G9D11

Which of the following is a disadvantage of multiband antennas?

- A. They present low impedance on all design frequencies
- B. They must be used with an antenna tuner
- C. They must be fed with open wire line
- D. They have poor harmonic rejection

G9B06

Where should the radial wires of a ground-mounted vertical antenna system be placed?

- A. As high as possible above the ground
- B. Parallel to the antenna element
- C. On the surface of the Earth or buried a few inches below the ground
- D. At the center of the antenna

G9B05

How does antenna height affect the horizontal (azimuthal) radiation pattern of a horizontal dipole HF antenna?

- A. If the antenna is too high, the pattern becomes unpredictable
- B. Antenna height has no effect on the pattern
- C. If the antenna is less than $\frac{1}{2}$ wavelength high, the azimuthal pattern is almost omnidirectional
- D. If the antenna is less than $\frac{1}{2}$ wavelength high, radiation off the ends of the wire is eliminated

G9D04

What is the primary purpose of antenna traps?

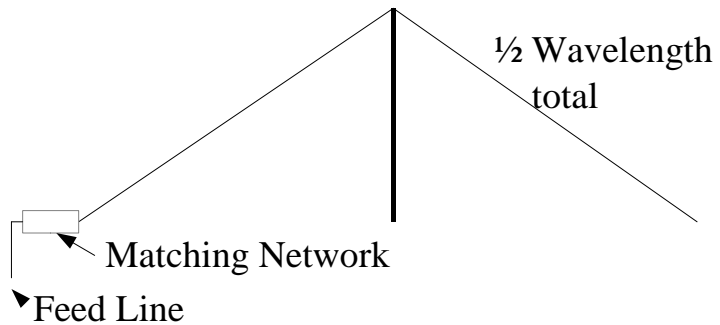
- A. To permit multiband operation
- B. To notch spurious frequencies
- C. To provide balanced feed point impedance
- D. To prevent out of band operation

G9B09

Which of the following is an advantage of a horizontally polarized antenna as compared to a vertically polarized HF antenna?

- A. Lower ground reflection losses
- B. Lower feed point impedance
- C. Shorter Radials
- D. Lower radiation resistance

Inverted V Dipole End Fed



End Fed Impedance is Very High
50:1 Unun is Used For Matching

G9D12

What is the common name of a dipole with a single central support?

- A. Inverted V
- B. Inverted L
- C. Sloper
- D. Lazy H

G9D02

What is the feed-point impedance of an end-fed half-wave antenna?

- A. Very low
- B. Approximately 50 ohms
- C. Approximately 300 ohms
- D. Very high

The correct answer is 2,500 ohms

Loop Antennas

Loops Less Than 1/3 Wavelength

- Vertical
- Used for Direction Finding

Loops Greater Than 1 Wavelength

- Horizontal
- Pattern Omnidirectional

Halo is Form of Loop $\frac{1}{2}$ Wavelength

- Horizontal
- Pattern Omnidirectional

G9D03

In which direction is the maximum radiation from a portable VHF/UHF "halo" antenna?

- A. Broadside to the plane of the halo
- B. Opposite the feed point
- C. Omnidirectional in the plane of the halo
- D. Toward the halo's supporting mast

G9D10

In which direction or directions does an electrically small loop (less than 1/3 wavelength in circumference) have nulls in its radiation pattern?

- A. In the plane of the loop
- B. Broadside to the loop
- C. Broadside and in the plane of the loop
- D. Electrically small loops are omnidirectional

G9D13

What is the combined vertical and horizontal polarization pattern of a multi-wavelength, horizontal loop antenna?

- A. A figure-eight, similar to a dipole
- B. Four major loops with deep nulls
- C. Virtually omnidirectional with a lower peak vertical radiation angle than a dipole
- D. Radiation maximum is straight up

HF Antenna Safety

**Long Wire Antennas may allow
RF in the Shack**

**Ground mounted Antennas
Need to be protected from
People**

**Working on antenna
Tx Should be OFF**

G9B01

What is one disadvantage of a directly fed random-wire HF antenna?

- A. It must be longer than 1 wavelength
- B. You may experience RF burns when touching metal objects in your station
- C. It produces only vertically polarized radiation
- D. It is more effective on the lower HF bands than on the higher bands

G0A06

What precaution should be taken when installing a ground-mounted antenna?

- A. It should not be installed higher than you can reach
- B. It should not be installed in a wet area
- C. It should be limited to 10 feet in height
- D. It should be installed such that it is protected against unauthorized access

Ground Plane Antenna

Very Simple Antenna

Vertical Polarized

Omnidirectional

Easy to Make

Female PL 259

Coat Hanger

Sloping Radials Downward

Increase Impedance to 50 Ω

G9B02

Which of the following is a common way to adjust the feed point impedance of a quarter wave ground plane vertical antenna to be approximately 50 ohms?

- A. Slope the radials upward
- B. Slope the radials downward
- C. Lengthen the radials
- D. Shorten the radials

G9B03

Which of the following best describes the radiation pattern of a quarter-wave, ground-plane vertical antenna?

- A. Bi-directional in azimuth
- B. Isotropic
- C. Hemispherical
- D. Omnidirectional in azimuth

KN6FW

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Beverage Antenna

Receiving Antenna

High Losses TX

Long Wire Type

Highly Directional

That's Harold Beverage

Not BUDweiser Beverage

G9D09

What is the primary use of a Beverage antenna?

- A. Directional receiving for low HF bands
- B. Directional transmitting for low HF bands
- C. Portable direction finding at higher HF frequencies
- D. Portable direction finding at lower HF frequencies

KN6FW

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GAIN ANTENNAS

- **Gain antennas**

- Compress power in one direction
- Lower the angle of radiation
- Can Null Out Interfering Stations

- **Yagi**

- Reflector (back end - longer)
- Driven element (next to reflector - 1/2 wavelength)
- Director(s) (front - shorter)
- Gain determined by
 - Boom length
 - Number of directors (elements)
- Bandwidth
 - Larger element diameters
- Can be made for multibands (Traps)
 - One feed line
 - Bad for harmonics
- Front to Back Ratio
 - Design for low response to the rear
 - Position of Elements
- 3 Element Yagi Has a Gain of About 6 dB or 9 dBi
- A Dipole Has 2.15 dBi "Gain"

G9C01

Which of the following would increase the bandwidth of a Yagi antenna?

- A. Larger diameter elements
- B. Closer element spacing
- C. Loading coils in series with the element
- D. Tapered-diameter elements

G9C05

How does increasing boom length and adding directors affect a Yagi antenna?

- A. Gain increases
- B. Beamwidth increases
- C. Front to back ratio decreases
- D. Front to side ratio decreases

G9C10 (D)

Which of the following can be adjusted to optimize forward gain, front-to-back ratio, or SWR bandwidth of a Yagi antenna?

- A. The physical length of the boom
- B. The number of elements on the boom
- C. The spacing of each element along the boom
- D. All these choices are correct

G9C07

What does "front-to-back ratio" mean in reference to a Yagi antenna?

- A. The number of directors versus the number of reflectors
- B. The relative position of the driven element with respect to the reflectors and directors
- C. The power radiated in the major radiation lobe compared to the power radiated in exactly the opposite direction
- D. The ratio of forward gain to dipole gain

G9C11

Which HF antenna would be the best to use for minimizing interference?

- A. A quarter-wave vertical antenna
- B. An isotropic antenna
- C. A directional antenna
- D. An omnidirectional antenna

G9C04

How does antenna gain stated in dBi compare to gain stated in dBd for the same antenna?

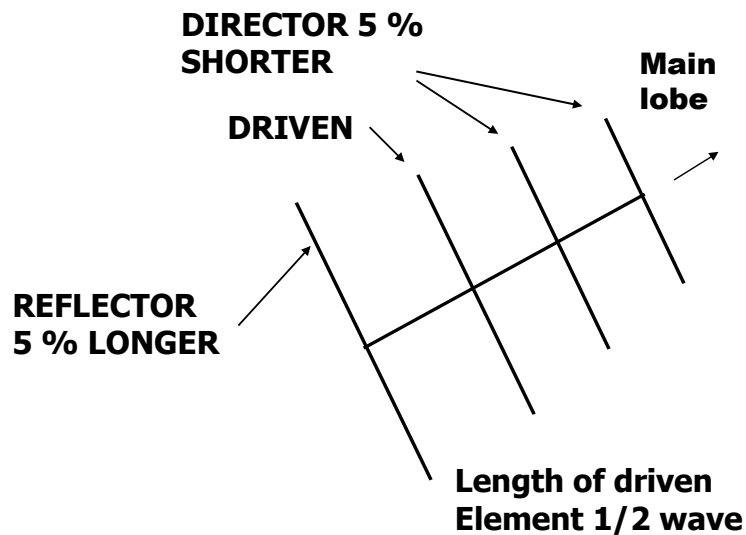
- A. dBi gain figures are 2.15 dB lower than dBd gain figures
- B. dBi gain figures are 2.15 dB higher than dBd gain figures
- C. dBi gain figures are the same as the square root of dBd gain figures multiplied by 2.15
- D. dBi gain figures are the reciprocal of dBd gain figures + 2.15 dB

G9C15

What is meant by the terms dBi and dBd when referring to antenna gain?

- A. dBi refers to an isotropic antenna, dBd refers to a dipole antenna
- B. dBi refers to an ionospheric reflecting antenna, dBd refers to a dissipative antenna
- C. dBi refers to an inverted-vee antenna, dBd refers to a downward reflecting antenna
- D. dBi refers to an isometric antenna, dBd refers to a disccone antenna

YAGI ANTENNA

**G9C02**

What is the approximate length of the driven element of a Yagi antenna?

- A. 1/4 wavelength
- B. 1/2 wavelength
- C. 3/4 wavelength
- D. 1 wavelength

G9C03

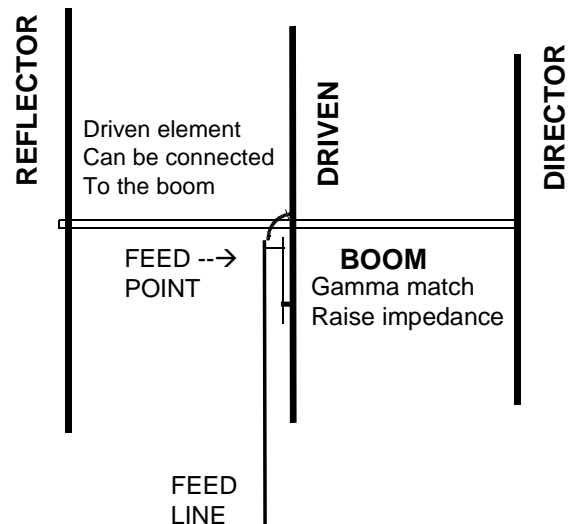
How do the lengths of a three-element Yagi reflector and director compare to that of the driven element?

- A. The reflector is longer, and the director is shorter**
- B. The reflector is shorter, and the director is longer**
- C. They are all the same length**
- D. Relative length depends on the frequency of operation**

G9C08

What is meant by the "main lobe" of a directive antenna?

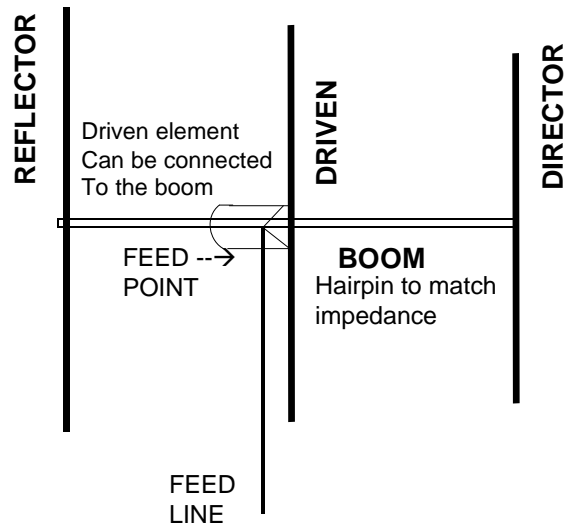
- A. The magnitude of the maximum vertical angle of radiation**
- B. The point of maximum current in a radiating antenna element**
- C. The maximum voltage standing wave point on a radiating element**
- D. The direction of maximum radiated field strength from the antenna**



G9C12

Which of the following is an advantage of using a gamma match for impedance matching of a Yagi antenna to 50 ohm coax feed line?

- A. It does not require that the elements be insulated from the boom**
- B. It does not require any inductors or capacitors**
- C. It is useful for matching multiband antennas**
- D. All of these choices are correct**



G9C16

What is a beta or hairpin match?

- A. It is a shorted transmission line stub placed at the feed point of a Yagi antenna to provide impedance matching
- B. It is a wavelength section of 75 ohm coax in series with the feed point of a Yagi to provide impedance matching
- C. It is a series capacitor selected to cancel the inductive reactance of a folded dipole antenna
- D. It is a section of 300 ohm twinlead used to match a folded dipole antenna

Yagi's Can Be Stacked

About 3 dB Gain

More Gain Means Tighter Beam Width

G9C09

How does the gain of two 3-element horizontally polarized Yagi antennas spaced vertically 1/2 wavelength apart typically compare to the gain of a single 3-element Yagi?

- A. Approximately 1.5 dB higher
- B. Approximately 3 dB higher
- C. Approximately 6 dB higher
- D. Approximately 9 dB higher

G9D05

What is an advantage of vertical stacking of horizontally polarized Yagi antennas?

- A. It allows quick selection of vertical or horizontal polarization
- B. It allows simultaneous vertical and horizontal polarization
- C. It narrows the main lobe in azimuth
- D. It narrows the main lobe in elevation

Log Periodic Antenna

Wide Bandwidth

Slightly Less Gain than a Yagi

All Elements Driven

Element Lengths logarithmic

G9D06

Which of the following is an advantage of a log periodic antenna?

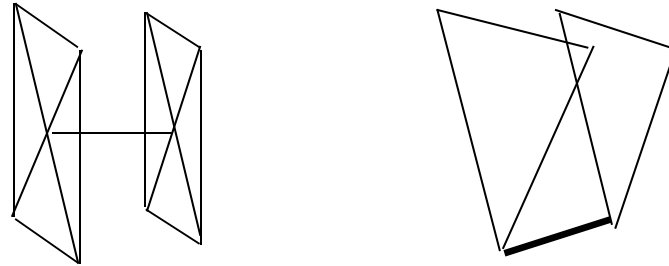
- A. Wide bandwidth
- B. Higher gain per element than a Yagi antenna
- C. Harmonic suppression
- D. Polarization diversity

G9D07

Which of the following describes a log periodic antenna?

- A. Length and spacing of the elements increase logarithmically from one end of the boom to the other
- B. Impedance varies periodically as a function of frequency
- C. Gain varies logarithmically as a function of frequency
- D. SWR varies periodically as a function of boom length

QUAD - DELTA



1 Wavelength Around the Loop

For the driven element

5% larger for reflector

2 Element Quad Gain about

Equal a 3 Element Yagi

Feed-point – Polarization

Bottom Center Horizontal

Side Center Vertical

G9C06

What configuration of the loops of a two-element quad antenna must be used for the antenna to operate as a beam antenna, assuming one of the elements is used as a reflector?

- A. The driven element must be fed with a balun transformer
- B. There must be an open circuit in the driven element at the point opposite the feed point
- C. The reflector element must be approximately 5 percent shorter than the driven element
- D. The reflector element must be approximately 5 percent longer than the driven element

G9C13

Approximately how long is each side of the driven element of a quad antenna?

- A. 1/4 wavelength
- B. 1/2 wavelength
- C. 3/4 wavelength
- D. 1 wavelength

G9C14

How does the forward gain of a two-element quad antenna compare to the forward gain of a three-element Yagi antenna?

- A. About 2/3 as much
- B. About the same
- C. About 1.5 times as much
- D. About twice as much

LOADED ANTENNAS

Make them seem longer

Capacitance hat

Coil of wire in the antenna

Usually at the Base

“Screwdriver” Antenna

Remotely tunable Coil

Makes the antenna “longer”

Rubber duck

HF antennas

Not as good as full length

Reduces bandwidth

G4E01

What is the purpose of a capacitance hat on a mobile antenna?

- A. To increase the power handling capacity of a whip antenna
- B. To allow automatic band changing
- C. To electrically lengthen a physically short antenna
- D. To allow remote tuning

G9D08

How does a "screwdriver" mobile antenna adjust its feed-point impedance?

- A. By varying its body capacitance
- B. By varying the base loading inductance
- C. By extending and retracting the whip
- D. By deploying a capacitance hat

HF Mobile Antennas

Ground ?

The Car

Length

Loaded

Narrow Bandwidth

Corona Ball

Tip of antenna

High voltage point

G4E02

What is the purpose of a corona ball on a HF mobile antenna?

- A. To narrow the operating bandwidth of the antenna
- B. To increase the "Q" of the antenna
- C. To reduce the chance of damage if the antenna should strike an object
- D. To reduce high voltage discharge from the tip of the antenna

G4E05

Which of the following most limits an HF mobile installation?

- A. "Picket fencing"**
- B. The wire gauge of the DC power line to the transceiver**
- C. Efficiency of the electrically short antenna**
- D. FCC rules limiting mobile output power on the 75-meter band**

G4E06

What is one disadvantage of using a shortened mobile antenna as opposed to a full size antenna?

- A. Short antennas are more likely to cause distortion of transmitted signals**
- B. Short antennas can only receive circularly polarized signals**
- C. Operating bandwidth may be very limited**
- D. Harmonic radiation may increase**

WHY COAX?

It is shielded

No radiation

Can be run next to metal

It can be run under ground

It is unbalanced

Can be converted to balanced

Balun

Transformer

Cut off any excess

Length = loss

Loss increases with frequency

If coax gets hot replace it

COAX

- **RG 58**
 - 50 ohm 3dB loss per 100 ft @ 100 MHz
- **RG 59**
 - 72 ohm 3dB loss per 100 ft @ 100 MHz
- **RG 8**
 - 50 ohm 2.5dB loss per 100 ft @ 100 MHz
- **RG 213**
 - 50 ohm 2.5 dB loss per 100 ft @ 100 MHz
- **RG 174**
 - 50 ohm 11 dB loss per 100 ft @ 100 MHz
- **9913**
 - 50 ohm 1.3 dB loss per 100 ft @ 100 MHz

G9A06 (D)

In what units is RF feed line loss usually expressed?

- A. Ohms per 1000 feet
- B. Decibels per 1000 feet
- C. Ohms per 100 feet
- D. Decibels per 100 feet

SWR (STANDING WAVE RATIO)

- **SWR**
 - A ratio of the forward power to the antenna to the reflected power returned from the antenna
 - Can be read as voltage with a slotted line
- Cause
 - Mismatch of Impedance
 - 50 Ω to 100 Ω = SWR of 2:1
- **Power meter**
 - 50 Ohms typical
 - SWR = $\frac{\text{Forward} + \text{Reflected}}{\text{Forward} - \text{Reflected}}$
- **SWR meter**
 - Do not use a HF SWR meter at VHF
 - Measures SWR directly
- **Connected**
 - Between transmitter and transmission line
- **Readings**
 - 1:1 Very good 1.5:1 Good 4:1 Bad

ANTENNA TUNER

Makes a correct match to any antenna

Looks like 50 ohms to transmitter

G4A06

What type of device is often used to match transmitter output impedance to an impedance not equal to 50 ohms?

- A. Balanced modulator
- B. SWR Bridge
- C. Antenna coupler or antenna tuner
- D. Q Multiplier

FCC RULES PART 97

Station Operation Standards

Technical Standards

Emergency Communications

NOT

Construction Standards

- Good engineering practice**
- Good amateur practice**
- CSCE Good for 365 Days**
- Identify with your call**
 - In English or CW
- With CSCE for General**
 - Call + "temporary AG"
 - May Use General privileges

G1B11 [97.101(a)]

Who or what determines "good engineering and good amateur practice," as applied to the operation of an amateur station in all respects not covered by the Part 97 rules?

- A. The FCC
- B. The control operator
- C. The IEEE
- D. The ITU

G1D03 [97.9(b)]

On which of the following band segments may you operate if you are a Technician Class operator and have a CSCE for General Class privileges?

- A. Only the Technician band segments until your upgrade is posted in the FCC database
- B. Only on the Technician band segments until your license arrives in the mail
- C. On any General or Technician Class band segment
- D. On any General or Technician Class band segment except 30-meters and 60-meters

G1D06 [97.119(f)(2)]

When must you add the special identifier "AG" after your call sign if you are a Technician Class licensee and have a CSCE for General Class operator privileges, but the FCC has not yet posted your upgrade on its website ?

- A. Whenever you operate using General Class frequency privileges
- B. Whenever you operate on any amateur frequency
- C. Whenever you operate using Technician frequency privileges
- D. A special identifier is not required as long as your General Class license application has been filed with the FCC

G1D09 [97.9(b)]

How long is a Certificate of Successful Completion of Examination (CSCE) valid for exam element credit?

- A. 30 days
- B. 180 days
- C. 365 days
- D. For as long as your current license is valid

FCC Protection?

Keep Local and State Governments from Limiting Your Antenna

PRB-1

G1B06 [97.15(b), PRB-1, 101 FCC 2d 952 (1985)]
Under what conditions are state and local governments permitted to regulate Amateur Radio antenna structures?

- A. Under no circumstances, FCC rules takes priority
- B. At any time and to any extent necessary to accomplish a legitimate purpose of the state or local entity, provided that proper filings are made with the FCC
- C. Only when such structures exceed 50 feet in height and are clearly visible 1000 feet from the structure
- D. Amateur Service communications must be reasonably accommodated, and regulations must constitute the minimum practical to accommodate a legitimate purpose of the state or local entity

The FCC Rule Book “SHALL NOT”

* Except

Be paid for communication *

Profit from communication *

Retransmit signals *

Communicate with other services *

Broadcast or Play music*

Use code or ciphers*

Transmit False or Deceptive signals

Cause harmful interference

TX unidentified communication

**Use obscene, indecent or profane
language**

No list, use judgment

The Exceptions

Can transmit Government weather and propagation info One way transmissions for Morse code training

G1B04 [97.113(c)]

Which of the following transmissions is permitted?

- A. Unidentified transmissions for test purposes only
- B. Retransmission of other amateur station signals by any amateur station
- C. Occasional retransmission of weather and propagation forecast information from U.S. government stations
- D. Coded messages of any kind, if not intended to facilitate a criminal act

G1B05 [97.111((5)(b))]

Which of the following one-way transmissions are permitted?

- A. Unidentified test transmissions of less than one minute in duration
- B. Transmissions necessary to assist learning the International Morse code
- C. Regular transmissions offering equipment for sale, if intended for Amateur Radio use
- D. All these choices are correct

G1B07 [97.113(a)(4)]

What are the restrictions on the use of abbreviations or procedural signals in the Amateur Service?

- A. Only "Q" signals are permitted
- B. They may be used if they do not obscure the meaning of a message
- C. They are not permitted
- D. Only "10 codes" are permitted

G1E04 [97.13(b), 97.303, 97.311(b)]

Which of the following conditions require a licensed Amateur Radio operator to take specific steps to avoid harmful interference to other users or facilities?

- A. When operating within one mile of an FCC Monitoring Station
- B. When using a band where the Amateur Service is secondary
- C. When a station is transmitting spread spectrum emissions
- D. All of these choices are correct

Emergencies

Handle the Emergency

Any Way You Can

Life or Property Loss

Any Frequency

Any Mode of Communication

Get Location and Nature

FCC May Restrict Operations

President's War Emergency
Powers

G2B10 (C) [97.405(b)]

When is an amateur station allowed to use any means at its disposal to assist another station in distress?

- A. Only when transmitting in RACES**
- B. At any time when transmitting in an organized net**
- C. At any time during an actual emergency**
- D. Only on authorized HF frequencies**

Emergencies

Use Any Frequency

Provide All Help You Can

Use Phonetic Alphabet to Spell

Names and to Improve

Understanding. Example

Alpha, Bravo, Charlie, Delta

G2B02

What is the first thing you should do if you are communicating with another amateur station and hear a station in distress break in?

- A. Continue your communication because you were on the frequency first**
- B. Acknowledge the station in distress and determine what assistance may be needed**
- C. Change to a different frequency**
- D. Immediately cease all transmissions**

G2D07

Which of the following are examples of the NATO Phonetic Alphabet?

- A. Able, Baker, Charlie, Dog**
- B. Adam, Boy, Charles, David**
- C. America, Boston, Canada, Denmark**
- D. Alpha, Bravo, Charlie, Delta**

G2B11 [97.405]

What frequency should be used to send a distress call?

- A. Whichever frequency has the best chance of communicating the distress message
- B. Only frequencies authorized for RACES or ARES stations
- C. Only frequencies that are within your operating privileges
- D. Only frequencies used by police, fire or emergency medical services

G2B09 [97.407(a)]

Who may be the control operator of an amateur station transmitting in RACES to assist relief operations during a disaster?

- A. Only a person holding an FCC issued amateur operator license
- B. Only a RACES net control operator
- C. A person holding an FCC issued amateur operator license or an appropriate government official
- D. Any control operator when normal communication systems are operational

International Telecommunications Union

Frequency use in Regions

Wavelength band	ITU Region 1	ITU Region 2	ITU Region 3
<i>MF</i>	<i>kHz</i>		
160 m	1810-1850	1800-2000	1800-2000
<i>HF</i>	<i>MHz</i>		
80 m	3.50-3.60	3.50-3.60	3.50-3.60
75 m	3.60-3.80	3.60-4.00	3.60-3.90
40 m	7.0-7.2	7.0-7.3	7.0-7.2
30 m	10.10-10.15	10.10-10.15	10.10-10.15
20 m	14.00-14.35	14.00-14.35	14.00-14.35
17 m	18.068-18.168	18.068-18.168	18.068-18.168
15 m	21.00-21.45	21.00-21.45	21.00-21.45
12 m	24.89-24.99	24.89-24.99	24.89-24.99
10 m	28.0-29.7	28.0-29.7	28.0-29.7

G1A14 [97.301(d)]

Which of the following may apply in areas under FCC jurisdiction outside of ITU Region 2?

- A. Station identification may have to be in a language other than English
- B. Morse code may not be permitted
- C. Digital transmission may not be permitted
- D. Frequency allocations may differ

G1E06 [97.301, ITU Radio Regulations]

The frequency allocations of which ITU region apply to radio amateurs operating in North and South America?

- A. Region 4
- B. Region 3
- C. Region 2
- D. Region 1

International Telecommunications Union

An agency of the United Nations

US is in ITU Region 2

Management of frequency allocations

**Countries may Notify the ITU that They
Don't want HAMS to Talk**

G1B12 [97.111(a)(1)]

When is it permissible to communicate with amateur stations in countries outside the areas administered by the Federal Communications Commission?

- A. Only when the foreign country has a formal third party agreement filed with the FCC
- B. When the contact is with amateurs in any country except those whose administrations have notified the ITU that they object to such communications
- C. When the contact is with amateurs in any country as long as the communication is conducted in English
- D. Only when the foreign country is a member of the International Amateur Radio Union

Secondary User

Hams get to use the frequency if
they don't interfere with the
Primary user

Big deal on 440 MHz

G1A12 [97.303]

Which of the following applies when the FCC rules designate the Amateur Service as a secondary user on a band?

- A. Amateur stations must record the call sign of the primary service station before operating on a frequency assigned to that station
- B. Amateur stations are allowed to use the band only during emergencies
- C. Amateur stations are allowed to use the band only if they do not cause harmful interference to primary users
- D. Amateur stations may only operate during specific hours of the day, while primary users are permitted 24 hour use of the band

G1A13 [97.303(h)(2)(j)]

What is the appropriate action if, when operating on either the 30-meter or 60-meter bands, a station in the primary service interferes with your contact?

- A. Notify the FCC's regional Engineer in Charge of the interference
- B. Increase your transmitter's power to overcome the interference
- C. Attempt to contact the station and request that it stop the interference
- D. Move to a clear frequency or stop transmitting

Power Out

Peak Envelope Power (PEP)

RMS Power at Max Modulation

Most band 1500 Watts PEP

100 Watts PEP referred to a dipole antenna on
60 Meters

Any other Antenna must be logged

200 Watts PEP on 30 Meters - 10 MHz

100 Watts on Beacons

Use only power required Communicate

Check FCC rules for other limits

G1C12 [97.303(i)]

Which of the following is required by the FCC rules when operating in the 60-meter band?

- A. If you are using other than a dipole antenna, you must keep a record of the gain of your antenna
- B. You must keep a record of the date, time, frequency, power level and stations worked
- C. You must keep a record of all third party traffic
- D. You must keep a record of the manufacturer of your equipment and the antenna used

G1C01 [97.313(c)(1)]

What is the maximum transmitting power an amateur station may use on 10.140 MHz?

- A. 200 watts PEP output
- B. 1000 watts PEP output
- C. 1500 watts PEP output
- D. 2000 watts PEP output

G1C02 [97.313(a),(b)]

What is the maximum transmitting power an amateur station may use on the 12-meter band?

- A. 50 watts PEP output
- B. 200 watts PEP output
- C. 1500 watts PEP output
- D. An effective radiated power equivalent to 100 watts from a half-wave dipole

G1C04 [97.313(a)]

Which of the following limitations apply to transmitter power on every amateur band?

- A. Only the minimum power necessary to carry out the desired communications should be used
- B. Power must be limited to 200 watts when transmitting between 14.100 MHz and 14.150 MHz
- C. Power should be limited as necessary to avoid interference to another radio service on the frequency
- D. Effective radiated power cannot exceed 1500 watts

G1C14 [97.313(i)]

What is the maximum power limit on the 60-meter band?

- A. 1500 watts PEP
- B. 10 watts RMS
- C. ERP of 100 watts PEP with respect to a dipole
- D. ERP of 100 watts PEP with respect to an isotropic antenna

G1C05 [97.313(c)(2)]

Which of the following is a limitation on transmitter power on the 28 MHz band for a General Class control operator?

- A. 100 watts PEP output
- B. 1000 watts PEP output
- C. 1500 watts PEP output
- D. 2000 watts PEP output

G1C06 [97.313]

Which of the following is a limitation on transmitter power on the 1.8 MHz band?

- A. 200 watts PEP output
- B. 1000 watts PEP output
- C. 1200 watts PEP output
- D. 1500 watts PEP output

G1C15 [97.313]

What measurement is specified by FCC rules that regulate maximum power output?

- A. RMS
- B. Average
- C. Forward
- D. PEP

5 Min Break

BANDWIDTH

CW

**Very low About 100 Hz
Depends on Sending Speed**

Automatic Digital

Less Than 500 Hz

RTTY

Low About 500 Hz

PACTOR-III

2.3 kHz

Digital

**High the Symbol Rate the
Higher the Bandwidth**

SSB

**About 3 kHz
2.8 kHz on 60 Meters**

AM

About 6 kHz

FM

About 15 to 20 kHz

TV

About 6 MHz

G8A07

Which of the following phone emissions uses the narrowest bandwidth?

- A. Single sideband
- B. Double sideband
- C. Phase modulation
- D. Frequency modulation

G1E11 [97.221]

What is the Part 97 limit on the maximum bandwidth occupied by an automatically controlled digital station?

- A. 100 Hz
- B. 500 Hz
- C. 1 kHz
- D. 2 kHz

G1C03 [97.303(h)(1)]

What is the maximum bandwidth permitted by FCC rules for Amateur Radio stations transmitting on USB frequencies in the 60-meter band?

- A. 2.8 kHz
- B. 5.6 kHz
- C. 1.8 kHz
- D. 3 kHz

G8B05

What is the approximate bandwidth of a PACTOR-III signal at maximum data rate?

- A. 31.5 Hz
- B. 500 Hz
- C. 1800 Hz
- D. 2300 Hz

G8B06

What is the total bandwidth of an FM phone transmission having 5 kHz deviation and 3 kHz modulating frequency?

- A. 3 kHz
- B. 5 kHz
- C. 8 kHz
- D. 16 kHz

G8B10

What is the relationship between transmitted symbol rate and bandwidth?

- A. Symbol rate and bandwidth are not related
- B. Higher symbol rates require wider bandwidth
- C. Lower symbol rates require wider bandwidth
- D. Bandwidth is always half the symbol rate

SEPARATION Between Stations

**About same or a bit more
Than the bandwidth of the signal**

G2B04

When selecting a CW transmitting frequency, what minimum separation should be used to minimize interference to stations on adjacent frequencies?

- A. 5 to 50 Hz
- B. 150 to 500 Hz
- C. 1 to 3 kHz
- D. 3 to 6 kHz

G2B05

When selecting an SSB transmitting frequency, what minimum separation should be used to minimize interference to stations on adjacent frequencies?

- A. 5 to 50 Hz
- B. 150 to 500 Hz
- C. Approximately 3 kHz
- D. Approximately 6 kHz

Amateur Auxiliary Volunteer Monitoring Program “COPS” “OO”

G2D01

What is the Volunteer Monitoring Program?

- A. Amateur volunteers who are formally enlisted to monitor the airwaves for rules violations
- B. Amateur volunteers who conduct amateur licensing examinations
- C. Amateur volunteers who conduct frequency coordination for amateur VHF repeaters
- D. Amateur volunteers who use their station equipment to help civil defense organizations in times of emergency

G2D02

Which of the following are objectives of the Volunteer Monitoring Program?

- A. To conduct efficient and orderly amateur licensing examinations
- B. To encourage self-regulation and compliance with the rules by radio amateur operators
- C. To coordinate repeaters for efficient and orderly spectrum usage
- D. To provide emergency and public safety communications

G2D03

What skills learned during hidden transmitter hunts are of help to the Volunteer Monitoring Program?

- A. Identification of out of band operation
- B. Direction finding used to locate stations violating FCC Rules
- C. Identification of different call signs
- D. Hunters have an opportunity to transmit on non-amateur frequencies

THE TEST

VOLUNTEER EXAMINER (VE)

Ham operators that administer the ham test "for free"

Test Elements

- 2 Tech
- 3 General
- 4 Extra

Certificate of Completion for elements passed are good for 1 year

•To give a tech exam

- 3 VEs Present
- 18 Years old or older
- Hold General or higher
- Accredited by a VEC

G1D04 [97.509(3)(i)(c)]

Which of the following is a requirement for administering a Technician Class license examination?

- A. At least three General Class or higher VEs must observe the examination
- B. At least two General Class or higher VEs must be present
- C. At least two General Class or higher VEs must be present, but only one need be Extra Class
- D. At least three VEs of Technician Class or higher must observe the examination

G1D02 [97.509(b)(3)(i)]

What license examinations may you administer when you are an accredited VE holding a General Class operator license?

- A. General and Technician
- B. General only
- C. Technician only
- D. Extra, General and Technician

G1D05 [97.509(b)(3)(i)]

Which of the following must a person have before they can be an administering VE for a Technician Class license examination?

- A. Notification to the FCC that you want to give an examination
- B. Receipt of a CSCE for General Class
- C. Possession of a properly obtained telegraphy license
- D. An FCC General Class or higher license and VEC accreditation

G1D07 [97.509(b)(1)]

Volunteer Examiners are accredited by what organization?

- A. The Federal Communications Commission
- B. The Universal Licensing System
- C. A Volunteer Examiner Coordinator
- D. The Wireless Telecommunications Bureau

G1D08 [97.509(b)(3)]

Which of the following criteria must be met for a non-U.S. citizen to be an accredited Volunteer Examiner?

- A. The person must be a resident of the U.S. for a minimum of 5 years
- B. The person must hold an FCC granted Amateur Radio license of General Class or above
- C. The person's home citizenship must be in ITU region 2
- D. None of these choices is correct; a non-U.S. citizen cannot be a Volunteer Examiner

G1D10 [97.509(b)(2)]

What is the minimum age that one must be to qualify as an accredited Volunteer Examiner?

- A. 12 years
- B. 18 years
- C. 21 years
- D. There is no age limit

Credit for Expired License

General Class or Higher Must Pass Element 2

G1D01 [97.501, 97.505(a)]

Who may receive credit for the elements represented by an expired amateur radio license?

- A. Any person who can demonstrate that they once held an FCC issued General, Advanced, or Amateur Extra class license that was not revoked by the FCC
- B. Anyone who held an FCC issued amateur radio license that has been expired for not less than 5 years and not more than 15 years
- C. Any person who previously held an amateur license issued by another country, but only if that country has a current reciprocal licensing agreement with the FCC
- D. Only persons who once held an FCC issued Novice, Technician, or Technician Plus license

G1D11

If a person has an expired FCC issued amateur radio license of General Class or higher, what is required before they can receive a new license?

- A. They must have a letter from the FCC showing they once held an amateur or commercial license
- B. There are no requirements other than being able to show a copy of the expired license
- C. The applicant must be able to produce a copy of a page from a call book published in the USA showing his or her name and address
- D. The applicant must pass the current element 2 exam

HAM LICENSE

Operators license

License class - determines privileges

Authorization to operate

In FCC database

Station license

Call sign

Address of primary station

Written authorization for station

May operate any number of transmitters

Responsible for operation

Post or carry A COPY

Required to operate on HAM bands

LICENSE TERM

10 YEARS

Renew 60 - 90 days before it expires!

2 year grace period

Renew with 610 form

LICENSE REQUIREMENTS

- No age requirement
- Anyone except a **representative**
of a foreign government
- Fill out form 610 & pay the \$
- PASS THE TEST!**
- Keep your address current
 - If the FCC can't send you mail
you could loose your license
- Don't lose the original

$$\frac{300,000,000}{10 \text{ METERS}} = 30 \text{ MHz}$$

10 METERS = 28.000 MHz to 29.7 MHz

Original HF HAM Bands

80 METERS = 3.5 MHz to 4.0 MHz
40 METERS = 7.0 MHz to 7.3 MHz
20 METERS = 14.0 MHz to 14.350 MHz
15 METERS = 21.0 MHz to 21.450 MHz
10 METERS = 28.0 MHz to 29.7 MHz

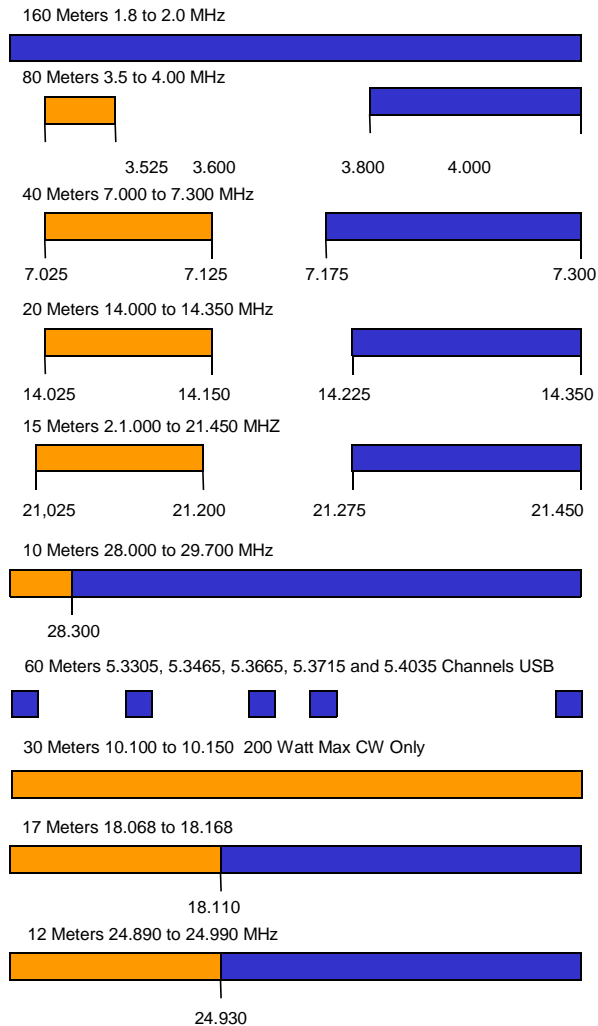
General Bands 80,40,20,15

Never start with .000
Phone band ends at the upper band edge

Always missing a small piece of the band at
the lower end of the CW and Phone sections

About 1/2 of the band is CW (the lower end)
Bands are about .3 MHz to .5 MHz wide

HF Frequencies



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Frequency X Wavelength = 300,000,000
Wavelength = 300 / Freq in MHz
Frequency MHz = 300 / Wavelength

G1A09 [97.301(d)]

Which of the following frequencies is within the General Class portion of the 15-meter band?

- A. 14250 kHz
- B. 18155 kHz
- C. 21300 kHz
- D. 24900 kHz

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150

G1A11 [97.301]

When General Class licensees are not permitted to use the entire voice portion of a particular band, which portion of the voice segment is generally available to them?

- A. The lower frequency end
- B. The upper frequency end
- C. The lower frequency end on frequencies below 7.3 MHz and the upper end on frequencies above 14.150 MHz
- D. The upper frequency end on frequencies below 7.3 MHz and the lower end on frequencies above 14.150 MHz

G1A01 [97.301(d)]

On which of the following bands is a General Class license holder granted all amateur frequency privileges?

- A. 60, 20, 17, and 12 meters
- B. 160, 80, 40, and 10 meters
- C. 160, 60, 30, 17, 12, and 10 meters
- D. 160, 30, 17, 15, 12, and 10 meters

G1A02 [97.305]

On which of the following bands is phone operation prohibited?

- A. 160 meters
- B. 30 meters
- C. 17 meters
- D. 12 meters

G1A03 [97.305]

On which of the following bands is image transmission prohibited?

- A. 160 meters
- B. 30 meters
- C. 20 meters
- D. 12 meters

G1A05 [97.301(d)]

Which of the following frequencies is in the General Class portion of the 40-meter band?

- A. 7.250 MHz
- B. 7.500 MHz
- C. 40.200 MHz
- D. 40.500 MHz

G1A06 [97.301(d)]

Which of the following frequencies is within the General Class portion of the 75-meter phone band?

- A. 1875 kHz
- B. 3750 kHz
- C. 3900 kHz
- D. 4005 kHz

G1A07 [97.301(d)]

Which of the following frequencies is within the General Class portion of the 20-meter phone band?

- A. 14005 kHz
- B. 14105 kHz
- C. 14305 kHz
- D. 14405 kHz

G1A08 [97.301(d)]

Which of the following frequencies is within the General Class portion of the 80-meter band?

- A. 1855 kHz
- B. 2560 kHz
- C. 3560 kHz
- D. 3650 kHz

G1A10 [97.301(d)]

Which of the following frequencies is available to a control operator holding a General Class license?

- A. 28.020 MHz
- B. 28.350 MHz
- C. 28.550 MHz
- D. All of these choices are correct

G1A04 [97.303 (h)]

Which of the following amateur bands is restricted to communication on only specific channels, rather than frequency ranges?

- A. 11 meters
- B. 12 meters
- C. 30 meters
- D. 60 meters

Calling Any Station “CQ”

CQ not used on repeaters

It is used on simplex and HF

**CQ DX if you want stations
outside the lower 48**

G2D05 (C)

Which of the following is a good way to indicate on a clear frequency in the HF phone bands that you are looking for a contact with any station?

- A. Sign your call sign once, followed by the words "listening for a call" -- if no answer, change frequency and repeat
- B. Say "QTC" followed by "this is" and your call sign -- if no answer, change frequency and repeat
- C. Repeat "CQ" a few times, followed by "this is," then your call sign a few times, then pause to listen, repeat as necessary
- D. Transmit an unmodulated carrier for approximately 10 seconds, followed by "this is" and your call sign, and pause to listen -- repeat as necessary

G2A11

Generally, who should respond to a station in the contiguous 48 states who calls "CQ DX"?

- A. Any caller is welcome to respond
- B. Only stations in Germany
- C. Any stations outside the lower 48 states
- D. Only contest stations

REPEATER

Retransmits

Typically from a high location
Provides greater range for HTs
Automatic Control no operator
Requires two frequencies

Input

Output

10 meters 29.5 MHz and above

Lots of repeaters in metro areas

Coordination “required”

Paid for by owner

Individuals

Clubs

Open repeaters GOOD!

Groups

Closed repeaters BOO!

Linked

Echolink VoIP - Internet

G1E02 [97.205(b)]

When may a 10-meter repeater retransmit the 2-meter signal from a station having a Technician Class control operator?

- A. Under no circumstances
- B. Only if the station on 10-meters is operating under a Special Temporary Authorization allowing such retransmission
- C. Only during an FCC declared general state of communications emergency
- D. Only if the 10-meter repeater control operator holds at least a General Class license

G1A15 [97.205(b)]

What portion of the 10-meter band is available for repeater use?

- A. The entire band
- B. The portion between 28.1 MHz and 28.2 MHz
- C. The portion between 28.3 MHz and 28.5 MHz
- D. The portion above 29.5 MHz

Good Operating

Monitor B4 Transmitting

Follow the Band Plan

Stay Within General Privileges

Say Your Call to Break Into a Contact

G1B08 [97.101(a)]

When choosing a transmitting frequency, what should you do to comply with good amateur practice?

- A. Insure that the frequency and mode selected are within your license class privileges
- B. Follow generally accepted band plans agreed to by the Amateur Radio community
- C. Monitor the frequency before transmitting
- D. All of these choices are correct

G2A08 (B)

Which of the following is a recommended way to break into a contact when using phone?

- A. Say "QRZ" several times followed by your call sign
- B. Say your call sign during a break between transmissions by the other stations
- C. Say "Break Break Break" and wait for a response
- D. Say "CQ" followed by the call sign of either station

Third Party Someone not a Ham

Hams with Revoked license may not be a Third Party

Third Party Agreements required with Foreign Countries

Must ID with Both Calls in English

Messages of a Personal Nature or HAM BS

Emergencies No Rules

G1E01 [97.115(b)(2)]

Which of the following would disqualify a third party from participating in stating a message over an amateur station?

- A. The third party's amateur license has been revoked and not reinstated
- B. The third party is not a U.S. citizen
- C. The third party is a licensed amateur
- D. The third party is speaking in a language other than English

G1E05 [97.115(a)(2),97.117]

What types of messages for a third party in another country may be transmitted by an amateur station?

- A. Any message, as long as the amateur operator is not paid
- B. Only messages for other licensed amateurs
- C. Only messages relating to Amateur Radio or remarks of a personal character, or messages relating to emergencies or disaster relief
- D. Any messages, as long as the text of the message is recorded in the station log

Single Sideband Usage

40 Meters and Below LSB

Every else Upper Sideband

G2A01

Which sideband is most commonly used for voice communications on frequencies of 14 MHz or higher?

- A. Upper sideband
- B. Lower sideband
- C. Vestigial sideband
- D. Double sideband

G2A02

Which of the following modes is most commonly used for voice communications on the 160-meter, 75-meter, and 40-meter bands?

- A. Upper sideband
- B. Lower sideband
- C. Vestigial sideband
- D. Double sideband

G2A03

Which of the following is most commonly used for SSB voice communications in the VHF and UHF bands?

- A. Upper sideband
- B. Lower sideband
- C. Vestigial sideband
- D. Double sideband

G2A04

Which mode is most commonly used for voice communications on the 17-meter and 12-meter bands?

- A. Upper sideband
- B. Lower sideband
- C. Vestigial sideband
- D. Double sideband

G2A05

Which mode of voice communication is most commonly used on the HF amateur bands?

- A. Frequency modulation
- B. Double sideband
- C. Single sideband
- D. Phase modulation

G2A06

Which of the following is an advantage when using single sideband as compared to other analog voice modes on the HF amateur bands?

- A. Very high fidelity voice modulation
- B. Less subject to interference from atmospheric static crashes
- C. Ease of tuning on receive and immunity to impulse noise
- D. Less bandwidth used and greater power efficiency

G2A07

Which of the following statements is true of the single sideband voice mode?

- A. Only one sideband and the carrier are transmitted; the other sideband is suppressed
- B. Only one sideband is transmitted; the other sideband and carrier are suppressed
- C. SSB is the only voice mode that is authorized on the 20-meter, 15-meter, and 10-meter amateur bands
- D. SSB is the only voice mode that is authorized on the 160-meter, 75-meter and 40-meter amateur bands

G2A09

Why do most amateur stations use lower sideband on the 160-meter, 75-meter and 40-meter bands?

- A. Lower sideband is more efficient than upper sideband at these frequencies
- B. Lower sideband is the only sideband legal on these frequency bands
- C. Because it is fully compatible with an AM detector
- D. Current amateur practice is to use lower sideband on these frequency bands

Equal Access to Frequencies This is NOT true!

G2B01

Which of the following is true concerning access to frequencies in non-emergency situations?

- A. Nets always have priority
- B. QSOs in progress always have priority
- C. Except during FCC declared emergencies, no one has priority access to frequencies
- D. Contest operations must always yield to non-contest use of frequencies

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HAM Etiquette

Ask if Frequency is in Use
Other Signals Interfering Move
DX if Long Distance

G2B03

What is good amateur practice if propagation changes during a contact and you notice interference from other stations on the frequency?

- A. Tell the interfering stations to change frequency
- B. Report the interference to your local Amateur Auxiliary Coordinator
- C. Attempt to resolve the interference problem with the other stations in a mutually acceptable manner
- D. Increase power to overcome interference

G2B06

What is a practical way to avoid harmful interference on an apparently clear frequency before calling CQ on CW or phone?

- A. Send "QRL?" on CW, followed by your call sign; or, if using phone, ask if the frequency is in use, followed by your call sign
- B. Listen for 2 minutes before calling CQ
- C. Send the letter "V" in Morse code several times and listen for a response or say "test" several times and listen for a response
- D. Send "QSY" on CW or if using phone, announce "the frequency is in use", then give your call and listen for a response

KN6FW

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G2B07

Which of the following complies with good amateur practice when choosing a frequency on which to initiate a call?

- A. Check to see if the channel is assigned to another station
- B. Identify your station by transmitting your call sign at least 3 times
- C. Follow the voluntary band plan for the operating mode you intend to use
- D. All of these choices are correct

STATION ID

- ID not required at the start
- ID every 10 min. & at the end
- ID with your call sign
- ID with Voice must be in English
(Communication may be in a different language)
- Use standard phonetics
 - Don't use cute words
- CW may always be used
- Repeaters 20 WPM max
- Upgrade with /AG or Authorized General
- No ID required for control of models, BUT Call sign, Name, & Address must be on the transmitter and 1 Watt max.
- ID with your call once per hour when using a special event call sign
- ID with your call followed by the call sign of the station you are using
- ID may contain Self-assigned indicator
 - May not confuse call sign

G2D09

Which of the following is required when participating in a contest on HF frequencies?

- A. Submit a log to the contest sponsor
- B. Send a QSL card to the stations worked, or QSL via Logbook of The World
- C. Identify your station per normal FCC regulations
- D. All these choices are correct

LOG

**Required Only if Antenna not a Dipole
on 60 Meters**

Helps if the FCC Asks ...

History of Contacts

Frequency, Time, Date and Call Sign

G2D08

What is a reason why many amateurs keep a station log?

- A. The ITU requires a log of all international contacts
- B. The ITU requires a log of all international third party traffic
- C. The log provides evidence of operation needed to renew a license without retest
- D. To help with a reply if the FCC requests information

Using Your HF Radio

Notch Filter

Block a Signal Interfering

CW High – Low Side

Less Interference

Intermediate Frequency (IF) Shift

Reduce Interference from Close signal

Split Mode

TX on One Frequency

RX on Another

40 Meters Outside the US

ALC Automatic Level Control

Control Modulation

Distortion from Over Drive (Flat Topping)

Excessive Bandwidth

Drive to a Power Amplifier

Over Drive can Damage a Solid State
Amp

G4A01

What is the purpose of the "notch filter" found on many HF transceivers?

- A. To restrict the transmitter voice bandwidth
- B. To reduce interference from carriers in the receiver passband
- C. To eliminate receiver interference from impulse noise sources
- D. To enhance the reception of a specific frequency on a crowded band

G4A02

What is one advantage of selecting the opposite or "reverse" sideband when receiving CW signals on a typical HF transceiver?

- A. Interference from impulse noise will be eliminated
- B. More stations can be accommodated within a given signal passband
- C. It may be possible to reduce or eliminate interference from other signals
- D. Accidental out of band operation can be prevented

G4A03

What is normally meant by operating a transceiver in "split" mode?

- A. The radio is operating at half power
- B. The transceiver is operating from an external power source
- C. The transceiver is set to different transmit and receive frequencies
- D. The transmitter is emitting an SSB signal, as opposed to DSB operation

G4A05

What is a reason to use Automatic Level Control (ALC) with an RF power amplifier?

- A. To balance the transmitter audio frequency response
- B. To reduce harmonic radiation
- C. To reduce distortion due to excessive drive
- D. To increase overall efficiency

G4A07

What condition can lead to permanent damage to a solid-state RF power amplifier?

- A. Insufficient drive power
- B. Low input SWR
- C. Shorting the input signal to ground
- D. Excessive drive power

G4A11

Which of the following is a use for the IF shift control on a receiver?

- A. To avoid interference from stations very close to the receive frequency
- B. To change frequency rapidly
- C. To permit listening on a different frequency from that on which you are transmitting
- D. To tune in stations that are slightly off frequency without changing your transmit frequency

G2A12

What control is typically adjusted for proper ALC setting on an amateur single sideband transceiver?

- A. The RF clipping level
- B. Transmit audio or microphone gain
- C. Antenna inductance or capacitance
- D. Attenuator level

G8A10

What is meant by the term "flat-topping" when referring to a single sideband phone transmission?

- A. Signal distortion caused by insufficient collector current
- B. The transmitter's automatic level control (ALC) is properly adjusted
- C. Signal distortion caused by excessive drive
- D. The transmitter's carrier is properly suppressed

G8A08

Which of the following is an effect of overmodulation?

- A. Insufficient audio
- B. Insufficient bandwidth
- C. Frequency drift
- D. Excessive bandwidth

G4D03

Which of the following can be the result of an incorrectly adjusted speech processor?

- A. Distorted speech
- B. Splatter
- C. Excessive background pickup
- D. All of these choices are correct

Using Your HF Radio 2

Dual VFO

Monitoring of 2 Frequencies

Speech Processor

Fancy ALC

Increases Average Power

Attenuator

Reduce Signal Overload

S Meter

Relative Received Signal
Strength

Different on most Radios

Antenna Tuner

Match TX - Antenna Impedance

VOX

Voice Operated Relay (Transmit)

G4A12

Which of the following is a common use for the dual VFO feature on a transceiver?

- A. To allow transmitting on two frequencies at once
- B. To permit full duplex operation, that is transmitting and receiving at the same time
- C. To permit monitoring of two different frequencies
- D. To facilitate computer interface

G4A13

What is one reason to use the attenuator function that is present on many HF transceivers?

- A. To reduce signal overload due to strong incoming signals
- B. To reduce the transmitter power when driving a linear amplifier
- C. To reduce power consumption when operating from batteries
- D. To slow down received CW signals for better copy

G4D04

What does an S meter measure?

- A. Conductance
- B. Impedance
- C. Received signal strength
- D. Transmitter power output

G4D06

Where is an S meter found?

- A. In a receiver
- B. In an SWR bridge
- C. In a transmitter
- D. In a conductance bridge

G4D01

What is the purpose of a speech processor as used in a modern transceiver?

- A. Increase the intelligibility of transmitted phone signals during poor conditions
- B. Increase transmitter bass response for more natural sounding SSB signals
- C. Prevent distortion of voice signals
- D. Decrease high-frequency voice output to prevent out of band operation

G4D02

Which of the following describes how a speech processor affects a transmitted single sideband phone signal?

- A. It increases peak power
- B. It increases average power
- C. It reduces harmonic distortion
- D. It reduces intermodulation distortion

G4A06

What type of device is often used to match transmitter output impedance to an impedance not equal to 50 ohms?

- A. Balanced modulator
- B. SWR Bridge
- C. Antenna coupler or antenna tuner
- D. Q Multiplier

G2A10

Which of the following statements is true of voice VOX operation versus PTT operation?

- A. The received signal is more natural sounding
- B. It allows "hands free" operation
- C. It occupies less bandwidth
- D. It provides more power output

RF in the Shack

BAD

Resonant Ground

Keep Grounds Short

High Impedance

Ground Everything (No Loops)

G4C05

What might be the problem if you receive an RF burn when touching your equipment while transmitting on an HF band, assuming the equipment is connected to a ground rod?

- A. Flat braid rather than round wire has been used for the ground wire
- B. Insulated wire has been used for the ground wire
- C. The ground rod is resonant
- D. The ground wire has high impedance on that frequency

G4C06

What effect can be caused by a resonant ground connection?

- A. Overheating of ground straps
- B. Corrosion of the ground rod
- C. High RF voltages on the enclosures of station equipment
- D. A ground loop

Digital Signal Processor

Very Fancy Filter

Bandwidths and Shapes

Remove Noise from Signal

Automatic Notching

G4C12

Which of the following is an advantage of a receiver DSP IF filter as compared to an analog filter?

- A. A wide range of filter bandwidths and shapes can be created
- B. Fewer digital components are required
- C. Mixing products are greatly reduced
- D. The DSP filter is much more effective at VHF frequencies

Tuning a Tube Final

Dip the Plate Current

Output Tuned to the Frequency

Increase the coupling to not exceed the Tubes Rating

G4A04

What reading on the plate current meter of a vacuum tube RF power amplifier indicates correct adjustment of the plate tuning control?

- A. A pronounced peak
- B. A pronounced dip
- C. No change will be observed
- D. A slow, rhythmic oscillation

G4A08

What is the correct adjustment for the load or coupling control of a vacuum tube RF power amplifier?

- A. Minimum SWR on the antenna
- B. Minimum plate current without exceeding maximum allowable grid current
- C. Highest plate voltage while minimizing grid current
- D. Maximum power output without exceeding maximum allowable plate current

Two Tone Test

**Two non-harmonically related
Audio Signals**

Used to check Linearity

G4B15

What type of transmitter performance does a two-tone test analyze?

- A. Linearity
- B. Percentage of suppression of carrier and undesired sideband for SSB
- C. Percentage of frequency modulation
- D. Percentage of carrier phase shift

G4B07

What signals are used to conduct a two-tone test?

- A. Two audio signals of the same frequency shifted 90 degrees
- B. Two non-harmonically related audio signals
- C. Two swept frequency tones
- D. Two audio frequency range square wave signals of equal amplitude

Bandwidth Used

**Depends on Modulation
Check Band Edge**

USB

About 3 kHz above the carrier

LSB

About 3 kHz below the carrier

CW

About 150 Hz about the carrier

G4D08

What frequency range is occupied by a 3 kHz LSB signal when the displayed carrier frequency is set to 7.178 MHz?

- A. 7.178 to 7.181 MHz
- B. 7.178 to 7.184 MHz
- C. 7.175 to 7.178 MHz
- D. 7.1765 to 7.1795 MHz

G4D09

What frequency range is occupied by a 3 kHz USB signal with the displayed carrier frequency set to 14.347 MHz?

- A. 14.347 to 14.647 MHz
- B. 14.347 to 14.350 MHz
- C. 14.344 to 14.347 MHz
- D. 14.3455 to 14.3485 MHz

G4D10

How close to the lower edge of the phone segment should your displayed carrier frequency be when using 3 kHz wide LSB?

- A. At least 3 kHz above the edge of the segment
- B. At least 3 kHz below the edge of the segment
- C. At least 1 kHz below the edge of the segment
- D. At least 1 kHz above the edge of the segment

G4D11

How close to the upper edge of the phone segment should your displayed carrier frequency be when using 3 kHz wide USB?

- A. At least 3 kHz above the edge of the band
- B. At least 3 kHz below the edge of the band
- C. At least 1 kHz above the edge of the segment
- D. At least 1 kHz below the edge of the segment